CHAPTER XXV

INSTALLATION OF INSTRUMENTS

25.1. Introduction. Aircraft instruments are precision built, expensive, and indispensable to the operation and safety of the aircraft. Inspectors check their installation for compliance with the data on blueprints and with specifications and aircraft standards of workmanship.

25.2. Instrument-panel Supports. Inspection of the instrument panel with its many instruments requires careful attention to all details. The correct and safe installation of the instrument panel is important. Points to check are

1. Alignment and security of bolt installations of instrument panel with respects to its supports. Type, material, length, and safety of these bolts are to conform to blueprint requirements.

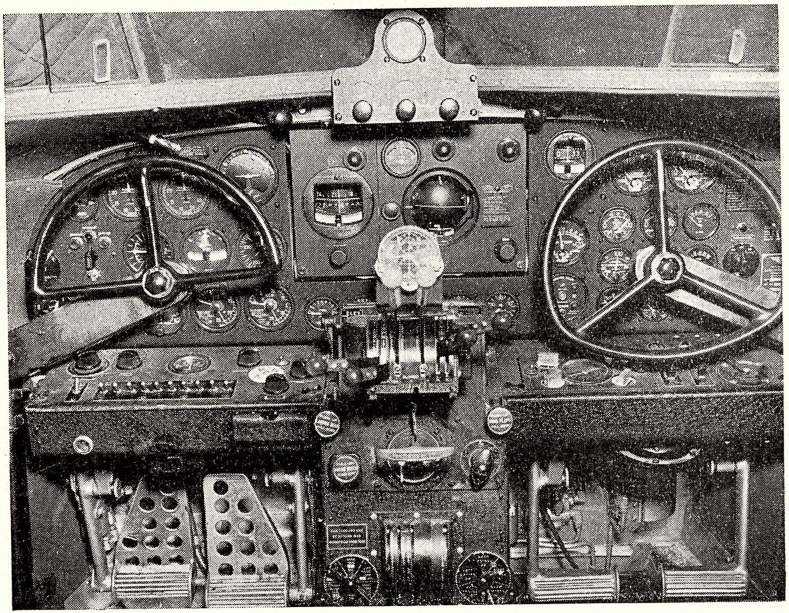
2. Alignment or adjustment of shock-absorber units and their installation. It is important for inspectors to check with the blueprint on specific type of shock absorber to be used and its location. The shock absorbers are designed to support and cushion certain weights; it is therefore important that the correct type be used in its proper place. Generally, those supporting the instrument panel at its lower end are stronger than those located at the top of the panel. Of importance is the manner of installation; the top side must be on top, or else the efficiency of the unit is rendered useless.

25.3. Bonding Provisions. Bonding provisions as required on the instrument panel are inspected for installation and compliance with bonding specifications.

25.4. Clearances. Clearances between instrument panel and adjacent structures are specified, and inspectors must see that they are as called for. The instrument-panel assembly should be located so that all its sides are parallel with corresponding sides of the airplane structure.

25.5. Installation of Instruments. The location of instruments is checked with the blueprint information, and the fit of such instruments in their cutouts is observed. The safety of their attachment is inspected and any distortion noted that may be caused by incorrect tightening of attaching provisions.

25.6. Instrument Dials. Dials and indicating pointers are checked. They must be correct, easily readable, neat, and undamaged. Pointers while at rest must be in specified positions. Where colors are used on the dials to indicate and identify operating ranges, these must correspond in color and location to all applicable specifications. Dials are inspected for appearance and neatness of color application.



Instrument panel on Lockheed-12 commercial transport plane. (*Courtesy of Lockheed Aircraft.*)

25.7. Glass on Instruments. Glass on instruments must not be cracked, chipped, foggy, or blurry.

25.8. Instrument Air Filters. Air filters provided for certain instruments are visually inspected. They must be clean. The safety of their installation is checked.

25.9. Safety Provisions on Instrument Adjustments. Safety provisions on exterior adjustments of instruments are closely observed and checked for compliance with all requirements.

25.10. Electrical Connections on Instruments. Electrical connections are to be secure in their supports, and terminals are checked for proper installation. Plug connections are to be in alignment, of proper fit, and not distorted or damaged. The blueprint is consulted for type and voltage of bulbs used for illuminating the instrument panel. Safety of electrical equipment and its installation is essential; inspectors are to observe all requirements for obtaining this safety.

25.11. Instrument Tubing Installations. Tubing installations and their connections are checked visually for external condition. Connections are to be in proper alignment and not overtightened. Condition, alignment, and safety of tubing supports and their installation are checked. Particular attention is given tubing at radii bends; any flattening of tubing at such points is to be noted. Lubrication specifications for threaded parts of tubing systems are to be complied with, and methods for bonding are to be observed and checked. Inspectors must inspect all tubing for proper and safe clearances at all points and for installation of lacings where required.

25.12. Flexible Hose Connections on Instruments. Flexible hose connections are inspected carefully for safety. Inspectors should note any unsatisfactory condition such as hoses being twisted, kinked, or otherwise damaged. It is important that flexible hoses should not be forced over too short a radius and that sufficient clearances should exist at all points. Proper alignment of flexible hose connections is important to the proper functioning of instruments. Misaligning hoses may have their interior passage partly obstructed, a full flow through the tubing being thus prevented.

25.13. Correct Routing of Instrument Lines. Routing of tubing is important and must be accomplished and proved correct before tubing is connected with the instruments.

25.14. Conclusion. A neat and correct installation of aircraft instruments shows the care and attention given to their work by the inspectors.

CHAPTER XXVI

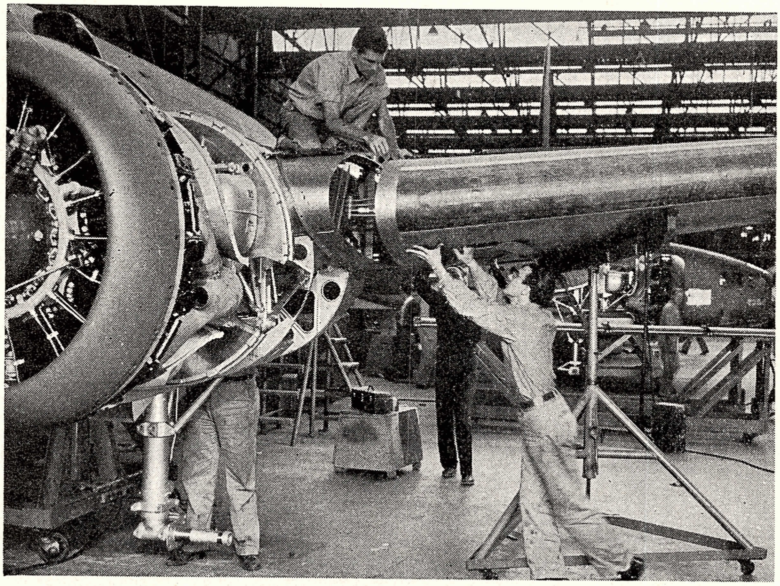
INSTALLATION OF OUTER WINGS

26.1. Final Assembly. In the final-assembly department the airplane is completed, checked, inspected, and made ready for delivery to the field-operations or flight department. Here are installed the outer wings, flight-control surfaces, fuselage furnishings, doors and hatches, etc.

Final connections are made of various systems of the airplane. Tests are carried out, such as the fuel-system leak check, the hydraulic check, and the automatic-pilot check. The method and procedures employed in making installations and operation checks in the final-assembly department depend on the design of the airplane and the methods and procedures established by factory authority. The following discussion is intended to be used as a guide, not as a hard-and-fast rule or method to be followed. Inspectors are to work according to information and procedure approved by factory authority.

26.2. Procedure Prior to Installation of Outer Wings. Before the outer wings are installed, inspectors check these for completeness and readiness of their installation surfaces and fittings. It is important to see that all technical requirements and specifications have been complied with and that accepted standards of workmanship have been followed. Main attaching fittings are inspected for cleanliness and absence of damage. No paint should be on the interior surfaces of holes. Lubrication specifications must be complied with. The surfaces and fittings on corresponding inner, or center, wings are inspected likewise, and only after the safety of these units has been definitely established are outer wings installed. It is very important that the wing be properly supported and held during installation of attaching bolts or pins. Alignment must be satisfactory, and no undue force must be used to accomplish the installation and attachment of the wing. Specifications regarding the lubricant to be used on bolts or pins and the method or procedure to be followed in installing the wing are to be observed in detail. Inspectors should observe the alignment of wing contour with mating surfaces. Where sealing provisions are required, they are checked and inspected according to authorized information.

26.3. Wing-attaching Bolts. Specifications stating certain torque-reading requirements on wing-installation bolts must be carefully adhered to in all details, and the inspectors are to watch such torque readings and record them in the prescribed manner. After installation of the outer wings, their connections with the inner, or center, wing are carefully inspected for safety of installation. A record of acceptance by inspection is made in the established manner.



Outer wing being installed on Lockheed Hudson bomber. (*Courtesy of Lockheed Aircraft.*)

CHAPTER XXVII

FINAL INSPECTION OF FLIGHT-CONTROL SYSTEM

27.1. Introduction. The inspection of the flight-control system, its installation, and operation is very exacting and carries great responsibilities. Hard work, attention to and familiarity with blueprint information, and a knowledge of specifications and standards of workmanship are essential.

27.2. Inspection of Flight-control Surfaces before Installation. Before flight-control surfaces are installed, they are inspected again, for the possibility of oversight or damage sustained in transit. Points to look for in inspecting these units prior to installation on the airplane are

1. Alignment of trailing edge (must not be warped).
2. Condition of surface covering (no loose or torn cloth edges, no holes, no flaws in paint, no worn spots, etc.)
3. No loose articles inside (turn the unit, and listen for noise of falling articles).
4. Drain holes open (openings neat and clean).
5. Tightness of covering satisfactory (test with finger).
6. Security and condition of attaching brackets or fittings (cotter pins or safety wire, installed as required; brackets or fittings not bent or otherwise damaged).
7. Condition of bearings (not rough, no poor staking or spinning, not damaged).
8. Trim tabs installed (satisfactory condition, alignment, and safety).

After these surfaces have been found satisfactory, they are released for installation on the airplane.

27.3. Preparation for Test Operation or "Roll-out." Before operating the system, it is necessary to check control-cable tension with authorized specifications and pass it if found satisfactory. The inspector must make certain that the operation of the system does not endanger the safety of men or equipment. This requires careful checking throughout the system. When all conditions have been established as being safe, the system is operated.

27.4. Inspection of System during Operation. The inspector operating the controls is to pay close attention to the amount of physical effort required to operate the system. Inspectors assisting inspect carefully the entire system while it is being operated *slowly* over its entire range of travel, from one extreme to the other. During movement of controls, inspectors are to listen for any "rubbing" noise which may be the result of no clearance at some point. Satisfactory and safe clearances are checked between moving parts and stationary parts or installations of the airplane. It is to be noted whether or not the controls rest against provided stops, as required in certain positions. Turnbuckles on control cables are not to cause interference by hitting each other, entering pulleys, touching on cutouts, or otherwise endangering the safe and proper functioning of the system. Turnbuckles are closely inspected for number of threads exposed and installation of their safety wire. Control cables are checked for possibility of vibrational contact between each other or adjacent surfaces and installations. Cables are checked for correct alignment with pulleys. Inspectors must see that pulleys rotate during the operation of the control system.

27.5. Bell Cranks. Attention must be given bell cranks or other parts of the system for the possibility of *overtravel* past dead center, which would make return movement impossible. Clearances are observed while bell cranks are in motion. The inspector must note whether or not connections on the bell crank bind in any position. The safety of such connections is inspected.

27.6. Self-aligning Bearing Connections. Units that have self-aligning bearing connections are inspected for safe and sufficient clearances at all points during movement. The safety of their installation is checked.

27.7. Rigid Connections. Rigid connections such as tubes or rods are checked for proper adjustment, freedom from binding, and thread penetration of their connecting ends. Thread penetration is checked through the inspection hole provided on such connections.

27.8. Direction and "Travel." It is important that inspectors check closely the travel, or "throws," of control surfaces for correct direction and amount of movement. The correct amount of travel, or throw, of control surfaces is given in engineering specifications. Inspectors must check to these specifications carefully and correctly; when travel is found satisfactory in all respects, it should be accepted and recorded in the prescribed manner.

27.9. Clearances. Inspectors check clearances between control surfaces and adjacent structures, also the safety of their installation, and the alignment of the trailing edge with adjacent surfaces.

27.10. Control-column Positions. Positions and required clearances of the control column, or stick, must be noted and checked according to authorized specifications while the control system is in neutral and during operation.

27.11. Rudder Pedals. Adjustment provisions and the position of rudder pedals are checked for satisfactory operation and compliance with authorized information.

27.12. General Procedure for Final Inspection. To facilitate inspection, an outline of procedure follows, to be used as a guide by inspectors:

Flight-control mechanism. *Check all surface controls for freedom of operation.*

A. Rudder-control system.
  1. Inspect rudder pedals for proper condition of pedal bearings and condition of pedal-adjusting mechanism.
  2. Check for lost motion.
  3. Check position of rudder with rudder pedals in neutral.
  4. Inspect safetying at all points and connections.
  5. Inspect for dirty, frayed cables, condition of serving on cables, and identification color on cable servings.
  6. Check cable tension according to specifications.
  7. Check for misaligned, bent, loose, broken, or cracked pulleys.
  8. Check safety of pulley installations.
  9. Check condition of all pulley supports for attachment (tightness, safety).
  10. Check clearance and freedom from interference between rudder and elevators in extreme throw positions.
  11. Check cable tension.
  12. Check adjustment and safety on turnbuckles.
  13. Check for safe clearances throughout system.

14. Check throws for compliance with specifications.
15. Check on whether or not controls rest against provided stops when in extreme positions.
16. Check cable alignment with pulleys and fairleads.
17. Check pulleys for rotation while system is in motion.
18. Check controls for proper direction of throws.

B. Rudder trim-tab system.

1. Check security and safetying of all cables, rods, and attachment fittings.
2. Check condition of cables, pulleys, cable drums, fairleads, rods, and operating mechanism.
3. Check position indicators on tab controls for coordinating indication with respect to position of tab.
4. Check for ease of operation.
5. Check for safe and sufficient clearances.
6. Check alignment of cables, pulleys, and fairleads.
7. Check cables for cleanliness (freedom from dirt, shavings, etc.).
8. Check system for proper direction of movement.

C. Aileron-control mechanism and system.

1. Inspect aileron-control wheel or stick assembly for proper condition, functioning, and safety, and also the condition and cleanliness of all bearings of the control mechanism.
2. Inspect entire aileron-control system for
    - *a*. Lost motion.
    - *b*. Effort required to operate system.
    - *c*. Proper direction of throws (system not crossed).
    - *d*. Proper safetying of all points and connections.
    - *e*. Frayed cables and condition of serving.
    - *f*. Cleanliness of cables.
    - *g*. Proper clearances and alignment of cables.
    - *h*. Turnbuckles adjusted correctly and safetied.
    - *i*. Cable tension according to specifications.
    - *j*. Color banding on cables according to specifications.
    - *k*. Misaligned, warped, broken, or cracked pulleys.
    - *l*. Safety of pulley installations.
    - *m*. Condition of all brackets and supports.
    - *n*. Safety of attachment of all brackets and supports.
    - *o*. Safety of cable guards.
    - *p*. Clearance between cable guard and cable.

- *q*. Position of ailerons when control is in neutral.
- *r*. Alignment of aileron trailing edges.
- *s*. Safety of aileron installations.
- *t*. Clearances of ailerons and adjacent surfaces.
- *u*. Controls hitting stops as required.

D. Aileron-tab control system.

1. Inspect for security and proper safetying of all cables, rods, and attachment fittings.
2. Check condition of cables, pulleys, cable drum, fairleads, rods, and operating mechanism.
3. Check for signs of interference with other parts.
4. Check tension of cables (note by pulling with hand).
5. Check operation of system and tab indicators.
6. Check indicators (they should show correct position of tabs).

E. Elevator-control mechanism.

1. Inspect and check elevator-control column or stick for proper functioning and correct assembly.
2. Note effort required to operate system.
3. Check for lost motion.
4. Inspect safetying of all points and connections.
5. Inspect cables for cleanliness.
6. Inspect cables for frayed or broken strands and condition of serving.
7. Check color banding according to specifications.
8. Inspect adjustment on turnbuckles and their safety.
9. Check cable tension according to specifications.
10. Check clearances of cables at all points.
11. Check alignment of cables with pulleys and fairleads.
12. Check for misaligned, warped, bent, loose, cracked, or broken pulleys.
13. Check condition and safety of pulley supports and brackets.
14. Check position of elevators when system is in neutral (trailing edge in alignment with adjacent surfaces).
15. Check for correct direction of throws (not crossed).
16. Check amount of throws according to specifications.
17. Check for system reaching stops as required.
18. Check for interference in the entire system during full-throw operation.

19. Check entire elevator-tab system for
    - *a*. Security and safetying of all cables, rods, and attachment fittings.
    - *b*. Condition of cables, pulleys, cable drums, fairleads, rods, and operating mechanism.
    - *c*. Sufficient and safe clearances over entire system.
    - *d*. Signs of interference with other parts.
    - *e*. Cleanliness of cables.
    - *f*. Ease of operation.
    - *g*. Tab alignment when in neutral.
    - *h*. Correct direction of movement and travel as specified.
    - *i*. Operation of tab indicators (to ensure that they show correctly the position of the tab).
    - *j*. Tension of tab control cables.

Flight-control surfaces. *Inspect all surfaces for holes or other visible damage and for general condition. Ailerons, elevators, and rudder are checked and inspected for*

1. Free and full movement.
2. Compliance with throw requirements.
3. Warping.
4. Installation and safety of bonding provisions.
5. Safety of attachments.
6. Signs of interference.
7. Condition of inspection covers (good fit, safety of installation).
8. Correct color on surfaces.
9. Absence of loose parts on inside (listen while surfaces are operated).
10. Absence of loose rivets, tears around cutouts, and other unsatisfactory conditions.

27.13. Conclusion. The importance of a correctly functioning control system and its safety is self-evident. Inspectors assigned to the inspection of the control system should check closely according to all authorized information such as that given on blueprints and specifications. Familiarity with approved shop practices and accepted aircraft standards of workmanship is required. The safety of a flight-control system is the responsibility of inspection personnel.

CHAPTER XXVIII

FINAL INSPECTION OF FUEL SYSTEM

28.1. Leak Check. While the airplane is in final assembly, its fuel system is given a proof check for leaks. The medium generally used is "solvent," a liquid authorized for use by the factory. A solvent liquid is used as a safety precaution, because aviation gasoline, if used in making the leak check, would endanger personnel and equipment and would constitute a fire hazard. It is important that all necessary inspection of the fuel system be completed and the system accepted and so recorded before a fuel-system check is made. Methods of giving this check may differ in details according to design requirements or prescribed factory method or procedure. However, the following gives a general description of a fuel-system leak check using solvent as the medium.

28.2. Preparatory Steps. Steps preparatory to the check are as follows:

1. The carburetor fuel line is disconnected where it enters the carburetor and its end closed leaktight by factory-approved methods. This is done on each engine.
2. All fuel strainers are checked for tightness or closed position.
3. The fuel tank or tanks are filled with a specified amount of solvent. Care is taken not to spill any liquid during filling operations.

28.3. Procedure. After these preparations are completed, the actual test is carried out as follows:

1. Specified pressure is built up in the system by use of the wobble pump or other factory-authorized methods.
2. The system is operated in the prescribed manner, and each part of the system is subjected to pressure.
3. While pressure is held, inspectors check the system carefully for evidence of leaks.
4. Where leaks are found, they are corrected, and the area surrounding the leak is dried and cleansed of liquid and again

checked under pressure. It is very often possible to correct a slight leak while the pressure is held in the part of the system in which the leak is located.

28.4. Reinstallation and Final Inspection. After inspectors have completed the leak check, the solvent is drained from the system. All strainers are removed and cleaned. The fuel lines which are disconnected and closed at their end are opened and reinstalled.

After all test operations are completed and the airplane system is returned to its former condition, the entire fuel system is checked and inspected.

28.5. Conclusion. For a general outline of points to inspect and note, see Chap. XVIII (Sec. 22). Inspectors accepting the fuel system in the final assembly must be conscious of their responsibility and make sure that they are passing a system that is correct, dependable, leakproof, and safely functioning.

CHAPTER XXIX

FINAL INSPECTION OF HYDRAULIC SYSTEM

29.1. Introduction. In the final-assembly department the hydraulic system of the airplane is given a final inspection and check for operation and safety before release to the flight department.

29.2. Preparatory Steps. Preparatory steps taken before operating the system are as follows:

1. A thorough check is made to determine that the airplane is properly and safely supported.
2. All areas in the vicinity of actuating or operating hydraulic units, installations, or surfaces are carefully checked for possible interferences.
3. The supply of hydraulic fluid in the storage tank is checked for correct level.
4. A general visual check is made of the entire system for safety of installations.
5. All personnel near or in the airplane is to be notified and cautioned that the hydraulic operation check is about to begin.

29.3. Beginning of Operation Check. Only after a complete check on the safety of personnel and equipment may the system be put into operation. The operation is carried out by means of the hydraulic hand pump located in the pilot's cockpit. This is done to prove that the system can be operated should the engine-driven hydraulic pumps fail.

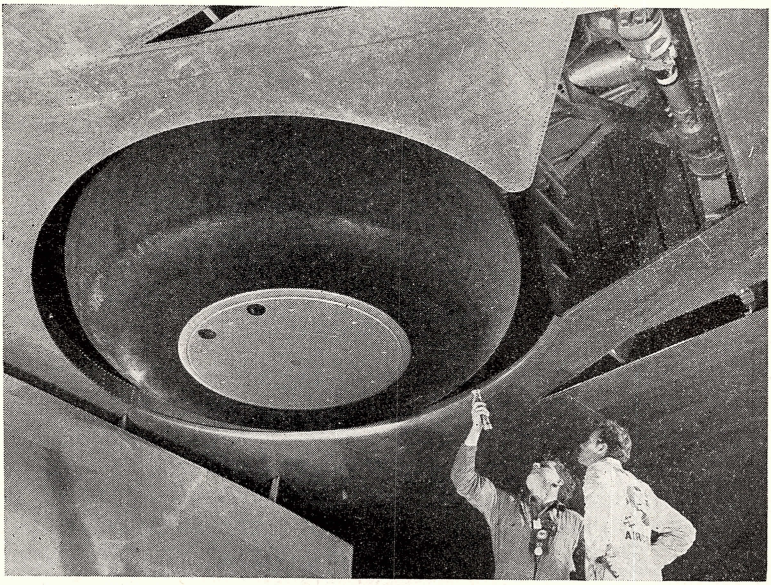
29.4. Procedure. It is important that all mechanical landing-gear locking provisions be released before "up" pressure is turned on. Inspectors are to note the release for correct adjustment of lock travel.

Actual operation of the various systems is observed and closely checked for proper direction, amount of movement as called for in authorized specifications, clearances at all points, and safety.

Locking provisions designed for hydraulic units such as landing gear and doors, are checked for proper operation and safety.

Position indicators and warning provisions are checked and inspected several times for correct and prompt functioning. These parts must conform to all technical requirements. Safety of installation and functioning is most important.

If covers or doors are connected to hydraulic units such as landing-gear units, inspectors must check and inspect for safety of the connections, correct travel movement, and absence of binding in any position. Closed doors are checked for fit, condition, and alignment. Particular attention is given the clearance between landing-gear tires and door when the door is closed. This clearance is to be within specified dimensions and tolerances. Bonding provisions are checked for safety and clearances while doors are opening or closing.



Landing gear in fully retracted position. Inspector is shown inspecting for clearances etc. (*Courtesy of Douglas Aircraft.*)

After all hydraulic-operation tests have been successfully completed and the unit has been accepted, the inspectors record this in the prescribed manner.

29.5. General Procedure for Final Inspection. Inspectors assigned to check and inspect the hydraulic system of the airplane generally check all units operated hydraulically. To facilitate inspection, an outline of procedure follows, to be used as a guide.

Landing gear.

1. Thoroughly inspect all attachment fittings and their installation for correctness and safety.
2. Inspect struts, braces, and fittings for
   - *a.* Cracks.
   - *b.* Bends.
   - *c.* Security and condition of attachment fittings.
   - *d.* Type of bolts used (correct or incorrect).
   - *e.* Loose, missing, or unsafetied bolts and nuts.
   - *f.* Safety of installation.
3. Inspect shock-absorber struts for evidence of leakage and for proper adjustment as specified.
4. Check and inspect mechanical-latch provisions for adjustment and safety of installation.
5. Check condition of hydraulic lines, flexible hoses, and connections.

Wheels and brakes.

1. Inspect all landing-gear wheels for bent or distorted rims and security of retaining parts.
2. Note inflation of tires.
3. Check alignment of tire slippage marks.
4. Inspect thoroughly, carefully, and systematically the brakes and brake-control mechanism from the operating pedals to the brakes.
5. Check adjustment of brakes according to engineering requirements.
6. Check condition of rubber surfaces on tires.

Landing-gear operation.

1. Check fluid level in hydraulic storage tank.
2. Check safety latches for proper operation.
3. Test retraction and extension of landing gear, using hand pump.
4. Check position-indicator settings for correctness.
5. Check functioning of warning provisions.
6. Inspect hydraulic operating mechanism for condition and functioning of control valves.

7. Check for correct direction and amount of movement.
8. Inspect for leakage of fluid or pressure in the hydraulic units.
9. Check for correct pressure indicated on hydraulic gage in pilot's cockpit.
10. See that gear-enclosure doors open and close freely; observe fit and alignment of doors.
11. Check condition and safety of cables and pulleys.
12. Check hydraulic system for entrapped air.
13. Inspect landing-gear assemblies for lubrication and condition of protective coatings.
14. Note time required for gear units to operate through their designed movement.
15. Note color identification on control handles.

Wing landing flaps.

1. Check installation for compliance with blueprint requirements.
2. Check safety of installation.
3. Check alignment with adjacent surfaces.
4. Check for sufficient and safe clearances.
5. Check adjustment of hydraulic-flap-actuating unit or units.
6. Check safety of actuating and operating controls and units.
7. Check clearances of all wing-flap controls.
8. Check for leaks in hydraulic system.
9. Check for correct direction of movement.
10. Check travel of wing flaps to specified requirements.
11. Inspect for evidence of interference.
12. Check position indicator for correct indication.
13. Inspect for freeness of movement; note bind if any.
14. Check for lost motion.
15. Check installation and safety of bonding provisions.
16. Check color identification on lines.
17. Check safety, alignment, and lacing of tubing installations.
18. Check surface condition of wing flaps.
19. Note time required for flaps to operate through their designed movement.
20. Note color identification on control handle.

Engine cowl flaps.

1. Inspect installation for compliance with blueprint requirements.
2. Check safety of installation.
3. Check condition of surfaces.
4. Check for lost motion or looseness of connections.
5. Check for correct alignment at connections.
6. Observe alignment of contours when closed.
7. Note presence of antifriction provision on surfaces of flaps where flaps overlap each other.
8. Check closely for sufficient and safe clearances.
9. Check safety of installation of hydraulic operating or actuating units.
10. Check for leaks in the system.
11. Check for evidence of interference.
12. Check for color identification on tubing.
13. Inspect safety of tubing supports and installations.
14. Check for correct direction of movement.
15. Inspect amount of travel according to specific engineering requirements.
16. Check time required to open or to close.
17. Check synchronization of cowl-flap movement between two or more engines.
18. Note color identification on control handles.
19. Note freeness of operation; no bind in any position.
20. Inspect and check entire cowl-flap system for correct and safe installation and operation.

29.6. Conclusion. The inspection of a complete and operating hydraulic system carries great responsibilities. Inspectors are advised to consult their superior whenever the slightest doubt exists of the safety of the hydraulic system.

CHAPTER XXX

INSPECTION OF THE SPERRY AIRCRAFT GYROPILOT IN THE FINAL-ASSEMBLY DEPARTMENT[1]

30.1. Introduction. It is important that information regarding the Sperry aircraft gyropilots be entirely accurate. Therefore, the contents of this chapter are reproduced exactly from publications of the Sperry Gyroscope Company.

30.2. Inspection after Completion of Installation. Upon completion of the installation or as the various phases of it are completed, a careful check and inspection should be made prior to running ground and flight tests.

30.3. Mechanical System. 1. The main control system of the airplane should be thoroughly checked out for freedom of operation and correct direction of operation. All connections should be checked to see that they are properly safetied. Observe the servo piston rods at this time to see that they do not spring or bend due to misalignment of pulleys which lead cable to the servo. Check to see that control-system stops are so placed as to prevent use of the servo as a stop. It is not necessary that the servo pistons be centered when the control surfaces are as long as the ship is rigged so that the surfaces have full angular movement without the servo pistons acting as stops.

2. The "On-Off" system should be checked to see that the hand lever produces a full 90 deg. throw at the servo and to see that the connections are not reversed. With the lever at "Off," the controls should move freely from one extreme to the other. With the lever "On," compression of air in the servo should be felt as the controls are moved back and forth. Later, when the air is replaced by oil (during the first running of engines), it will not be possible to move the controls manually with the gyropilot on, except by overpowering, which opens the servo relief valves.

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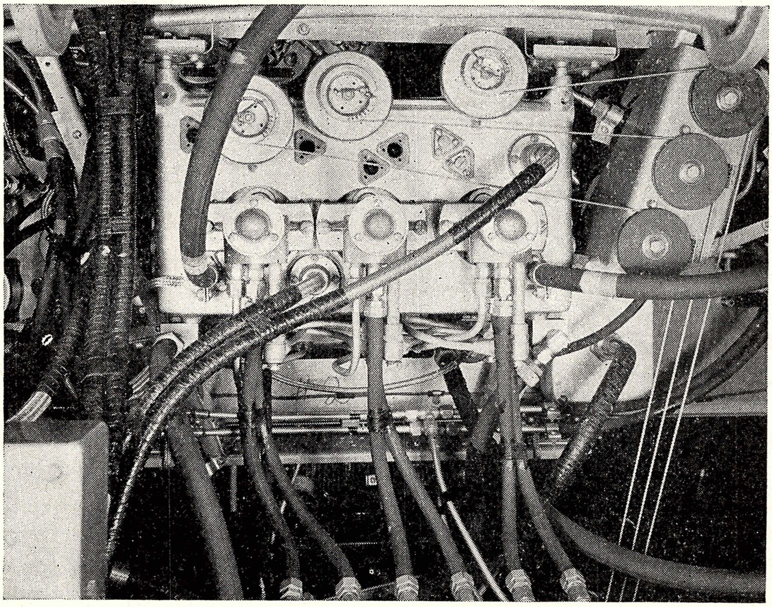
[1] The material in this chapter has been made available through the courtesy of the Sperry Gyroscope Company, Inc., 2200 East Imperial Highway, El Segundo, Calif.

3. The follow-up system should be checked as follows:

a. With gyro control units in place and follow-up indices and controls approximately centered, the following relations should hold:

Right rudder application should cause rudder follow-up card to move to the *left.*
Right aileron application should cause aileron follow-up index to move to the *right.*
Down elevator application should cause elevator follow-up index to move *up.*

If any of these motions is reversed, the relation between control movement and follow-up pulley rotation should be rechecked.

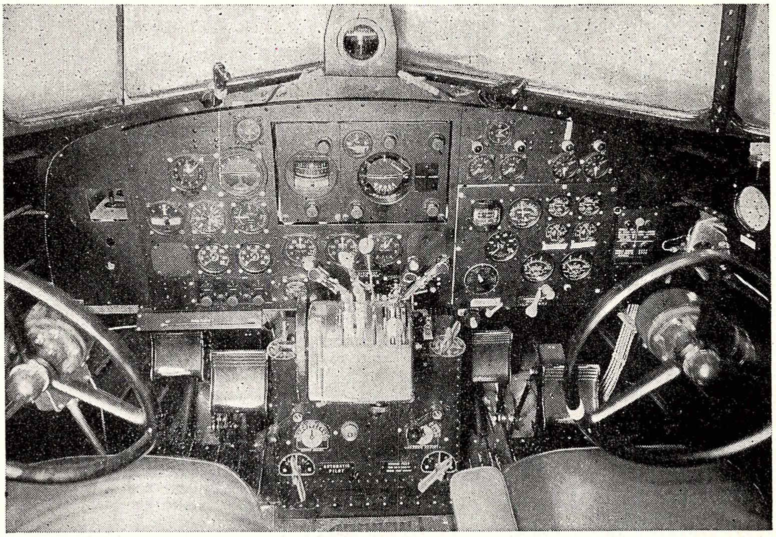


View of rear instrument panel showing the auto-pilot unit provisions. (*Courtesy of Douglas Aircraft.*)

b. Check to be sure that follow-up index motion is smooth as the controls are moved and to see that there is no lag. Should there be any lag or jerky movement of the follow-up, the system should be carefully gone over to eliminate the cause.

c. Check to see that all connections are properly safetied and that pulleys and cables are properly guarded, so that no chafing of cables can take place.

d. Be sure that there is tension in the follow-up cables when controls are at the extreme position feeding follow-up cable to the follow-up pulleys. Be sure that the pulley spring is not wound tight at the other extreme. It should be possible to move the pulley about one-quarter turn at this position.



View of instrument panel of Douglas-DST commercial sleeper transport plane. With auto pilot installed. (*Courtesy of Douglas Aircraft.*)

e. Be sure that the springs in the follow-up pulleys are not dry. A dry spring will rust and bind instead of giving a smooth motion. A few drops of heavy engine oil will suffice.

30.4. Hydraulic and Vacuum System. All piping should be traced out to see that it is connected according to diagrams furnished by the Sperry Gyroscope Company or in accordance with manufacturer's diagrams based on these. It is very important to catch any reversed connections at this time so that equipment will not be damaged later when the engines are run. Check to see that all joints are tight and all tubing is secure and protected from vibration. Be certain that tubing cannot chafe against any structure to cause a serious leak at a later date.

30.5. Electrical System. Wiring should be checked out with a buzzer to detect short circuits and to see that circuits are complete.

30.6. Installation Report. The installation report, Sperry form 1677, should be made out and forwarded to the Aeronautical Service Department of the Sperry Gyroscope Company, Inc., Brooklyn, N. Y. The information contained in the report will enable the company to render more efficient service when service is required.

30.7. Ground Test. Inspectors should know and be familiar with the methods and procedures of the ground operation test as authorized and approved by the Sperry Gyroscope Company. Arrangements are now possible by which the ground test is conducted in the final-assembly department by connecting a Sperry-furnished electric machine to the gyropilot system as prescribed by factory authority. This saves a test during engine run and permits any adjustments or corrections to be made before the airplane is delivered to the flight department.

30.8. Procedure.[1] No gyropilot installation should be flown until it has passed a satisfactory ground test. An installation which does not check satisfactorily on the ground cannot be expected to perform satisfactorily in the air. The ground test will catch any reversed connections not caught during the installation inspection.

Fill the oil sump tank three-fourths full, close speed control valves, and turn the gyropilot "Off."

Start electric Sperry pump and note whether the oil pressure gage and the vacuum gage indicate. Within 1 or 2 min. the oil pump should prime and indicate pressure. *Do not allow the pump to run dry more than 5 min.* After it is certain that vacuum and oil pumps are operating, run at a specified speed and set vacuum regulator for 4½ in. of mercury at the gage and the oil pressure regulator for the pressure it is believed will prove satisfactory. The speed valves should be closed while the oil pressure adjustment is being made.

The vacuum should not be less than 3 in. of mercury at a speed equal to 1000 r.p.m. or more than 5 in. of mercury with engine at maximum ground r.p.m.

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[1] The material under Procedure is an extract from *Instruction Bulletin* 15–728, published by the Sperry Gyroscope Company.

Open speed valves at least four turns. Each numeral represents one turn of the knob.

Center the controls, align the follow-up indices, and then operate the controls manually, moving them slowly from hard over to hard over independently and collectively a few times. Then hold each control at each extreme position for at least 30 sec. two or three times. This allows time for air in the servo to be pushed through the system by oil flow until it reaches the sump.

Shut down electric machine for a few moments to check for air in the servos and replenish oil in the sump which will have been passed on to the rest of the system. To check for air in the servos turn the gyropilot "On" (machine not running), in which case the controls should act as though locked. A resiliency indicates air in the servo which is compressed as force is applied to a control and which expands as force is removed. Do not confuse stretching of cable with air in servo. If any doubt exists observe the indices on the control units for movement when checking for air. Fill the sump three-fourths full before continuing with the ground test.

Adjust the servo relief valves in accordance with manufacturer's instructions.

Start electric motor of Sperry machine and run equivalent to 1000 r.p.m. Center all three controls, uncage gyros, open speed valves, align the follow-up indices with the gyro indications, and turn the gyropilot "On." All three controls should remain in position. (If the airplane is not level, the bank-and-climb gyro will move slowly toward the correct indication of the attitude of the airplane and cause the elevator and aileron controls to follow. The controls can then be recentered by rotating hand control knobs.)

Check for *direction-of-control* movement by moving each setting knob back and forth a small amount, ascertaining that each control moves in the direction marked at the knob.

Check for control speed balance as follows:

Open all three speed control valves wide. Turn the gyropilot "Off" for a moment and move the aileron control hard over. Turn gyropilot "On" quickly and count seconds for the wheel or stick to come to neutral. Repeat from the opposite side. Time of return should coincide within 25 per cent. Follow same procedure for rudder and elevator. Up elevator may be considerably slower than down elevator, especially on large airplanes, owing to the weight of the surface helping down movement and opposing up movement.

Check to be sure that the gyropilot can be overpowered with the gyropilot "On."

If the above tests show proper operation, the equipment is ready for flight test. Should any faulty performance result, correct in accordance with "trouble-shooting" information as given in manufacturer's information.

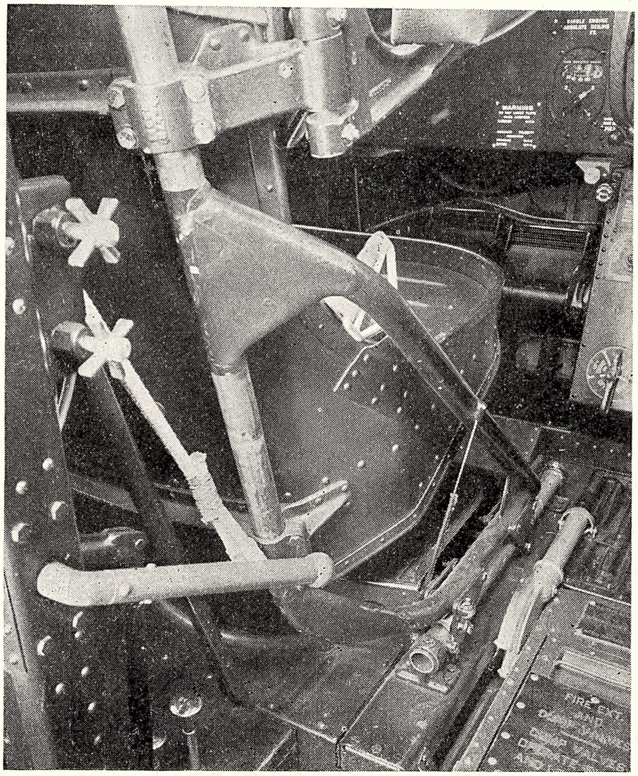
Disconnect the Sperry electric machine and reconnect the airplane system as required.

30.9. Conclusion. It is most important that only thoroughly trained personnel conduct the ground test of this precision equipment. Inspectors assigned to the inspection and checking of the Sperry gyropilot system must be familiar with all its characteristics in order to accept only a satisfactory and safe Sperry aircraft gyropilot system and its installations.

CHAPTER XXXI

FINAL INSPECTION OF FUSELAGE FURNISHINGS

31.1. Introduction. Fuselage furnishings are equipment such as seats, tables, provisions for parachute installations, and tool storage, and other miscellaneous equipment. Their correct installation, proper functioning, and safety are one of the responsibilities of inspection. To assist inspectors assigned to this equipment the following discussion may serve as a guide, in



Detail view of typical seat installation. (*Courtesy of Douglas Aircraft.*)

connection with factory-authorized information such as engineering blueprints and finish specifications.

31.2. Seats. The following points should be kept in mind in inspecting seat installations.

1. All technical requirements as shown on the blueprint must be complied with in detail.
2. Finish specifications must be complied with.
3. The general condition of the seat assembly itself must be satisfactory and free from any damage. Its surfaces are to be smooth. Sharp corners or rough edges are unsatisfactory and should be corrected.
4. Provisions for safety-belt installation must be checked closely and in detail. Their attachment should be checked for safety and alignment. The bolted parts of these provisions are inspected for installation of cotter pins and for correct position in relation to the seat. This is important, for the safety belt must fit correctly when used.

31.3. Safety Belts. The safety belt itself is checked for correct type and condition of material. The belt buckle is inspected for condition; it must be free from rough edges or surfaces and should not be bent or distorted. The open end of the belt, which does not carry the buckle, is inspected for condition; its sides should not be rough, nor should it be buckled or damaged. The condition of the belt end, or tip, is important for the effective, smooth, and quick release of the buckled belt. If the safety of the belt material is open to the slightest doubt, the belt must be replaced.

31.4. Seat Supports. Inspectors check to see that seat supports are in proper alignment with floor attachments. The safety of these installations is most important, and they are inspected with great care. The attachments are closely checked for conditions such as cracks, bent or distorted parts, overtightened bolt installations, or cotter pins omitted. The fit of seat and floor attachments is important, for any preloaded conditions endanger the safety of the entire seat installation. Where stop nuts are used, they are inspected for proper thread penetration as called for in factory-authorized specifications. Bolts and nuts are to seat properly on underlying surfaces and are to conform to accepted aircraft standards of workmanship. The safety of seat supports and their installation must be beyond any doubt.

31.5. Clearances for Seats. Clearances between the seat and adjacent structures or installations are inspected. These clearances should be sufficient and safe in the entire operation range of the seat. Inspectors must check clearances in the vicinity of seat installations by operating the seat in all possible directions. It is best to sit down in the seat and operate the seat through all possible movements, clearances at all points being noted.

31.6. Operation of Seats. Whatever motion the design permits, inspectors are to check this motion in every detail. The operation must be smooth and its range as designed, and inspectors should observe particularly the physical effort necessary to change the seat from one position to another. The operation must be satisfactory before acceptance by inspectors.

31.7. Locking Mechanism on Seats. It is important that any provision locking or holding a seat in a particular position be checked according to all blueprint requirements. The proper, smooth, dependable, and safe functioning of such mechanisms is essential. Inspectors are to seat themselves and put the locking or holding devices through all their various positions and operations. During such operations, inspectors should note the amount of physical effort required to release the lock and the functioning of the mechanism when the seat reaches a new position at which the locking mechanism is designed to lock. Compliance with any lubrication specifications is checked. The safety of any locking mechanism must be established beyond a doubt before its acceptance by inspection.

31.8. Cushions. If seats are provided with cushions or paddings such as arm rests, inspectors check these for their fit. Appearance and condition are noted, and any means of attachment to seats is inspected for security.

31.9. Lubrication Specifications. On certain component parts of seat installations, specifications call for lubrication. It is important that such requirements be followed. Inspectors check to see that lubrication is provided where called for and that any excess lubricant is cleaned off.

31.10. General Considerations. It is very important that inspectors should check seat installations for any condition that may cause injury or damage to personnel or clothing. The operation of seats and the safety of seats and their installations are the responsibility of inspectors.

31.11. Tables and Their Installations. Inspectors should check the general condition and appearance of tables. The surface should not be scratched, marred or buckled but should be smooth and level. Edges should not be sharp or damaged. If drawers are provided, they are inspected for condition and appearance, proper fit and ease of operation, absence of distortion, safety of installation, and correct travel.

During inspection of table installations, inspectors check closely alignment and safety of all attachments. Where provisions are installed for folding up a table or part of a table, these are checked for operation, safety, and general condition. Blueprint requirements are to be complied with in all details. Clearances are observed during the folding of a table or part of a table. It is noted whether or not conditions exist that may cause injury to personnel or clothing. The safety of table installations is essential.

31.12. Parachute Provisions. Where parachute provisions are installed, they are inspected for condition and safety of installation. It is important that they be installed according to blueprint information. Protection provided on such provisions is inspected for condition and safety of attachment. Inspectors should observe clearances of the installed parachute with adjacent surfaces. The installation of parachute provisions is checked for general appearance and correct and safe installation and according to accepted aircraft standards of workmanship.

31.13. Miscellaneous Equipment. Inspectors check to see that all other equipment is installed according to blueprint requirements. The safety of the installed equipment and its completeness are ascertained. Inspectors check to see that all information such as that contained in stencils is correct and neat in appearance. The tie-down, or locking, provisions are checked for fit, condition, operation, and safety. Clearances of such equipment with surrounding areas are to be sufficient and safe.

31.14. Conclusion. It is important that all fuselage furnishings should be installed according to blueprint requirements, should comply with finish specifications, should be safe, and should conform to accepted standards of workmanship. It is particularly important to correct any conditions that may cause injury to personnel or clothing. Safety of such installations is essential.

CHAPTER XXXII

FINAL INSPECTION OF DOORS, HATCHES AND ENCLOSURES, AND WINDOWS

32.1. Introduction. Correct and safe installation of doors, hatches and enclosures, and windows is vital to the safety of an airplane and its occupants. During inspection of such installations, inspectors must consider any and all conditions affecting their purpose. It is most important that such installations comply in every detail with blueprint requirements, finish specifications, and approved aircraft standards of workmanship. Safety is the result of compliance with all this information, which inspectors must consider the authority to follow.

The material in this chapter will serve as a guide to inspectors assigned to check the installation of doors, hatches, etc., in the final-assembly department.

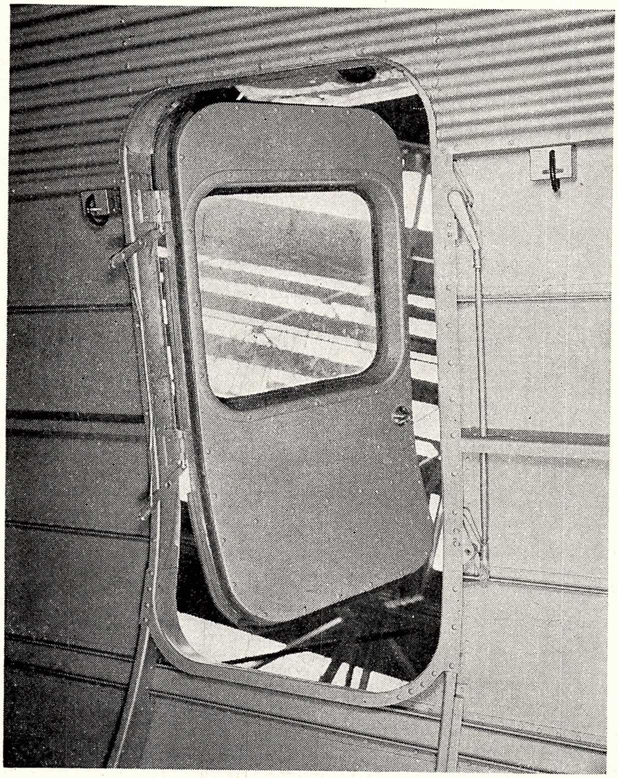
32.2. Inspection of Doors before Installation. General condition and appearance must be inspected, for damage may have been sustained during transit. The outside surfaces should not be scratched, nicked, or dented. The edges of the door skin, or cover, should not be bent or cracked. Sealing provisions are checked for appearance and condition of their installation or attachment. Compliance with finish specifications is checked. The color or color schemes must be according to requirements.

32.3. Interior of Doors. The interior of doors is inspected wherever possible. Inspectors check to see that no loose tools or other loose material is present. All surfaces must be undamaged and corners free from cracks in the vicinity of radii. Interior surfaces are observed for compliance with finish specifications. The safety of any bolts or nuts is checked, and the entire interior section of a door or hatch is inspected for general condition, appearance, and safety.

32.4. Door-locking Mechanism. The door-locking mechanism is carefully inspected for condition and safety. Alignment and connection of component parts are very important. The door mechanism is checked for operation; inspectors should particularly note the physical effort required to operate it through its entire range of movement. Any evidence of unusual drag or bind while the mechanism is operated should be carefully watched for. Where travel stops are provided, attention is given the position of the mechanism when resting against such stops. This is very important, especially so if such stops are designed for adjustment. The possibility of over- or past-dead-center travel must definitely be checked. It also is of importance to check the positions of the door strikers in both the open and the closed position. The strikers must extend in the closed position sufficiently far to ensure the safety of the installed door when closed. In the open position the strikers must be retracted sufficiently to ensure safe and quick opening of the installed door. Lubrication if required is checked for excessive use; any excess lubricant must be cleaned off. The inspector checks to see that the mechanism operates in the correct direction, as indicated (generally, doors have information stenciled on them saying "Open" and "Close"). The safety of the operating mechanism is of vital importance. When in doubt, the inspector should consult his immediate superior.

32.5. Doorjambs. Inspection of doorjambs is necessary for the purpose of observing conditions that may affect the installation. Inspectors check the installation of door hinges for type, kind of material, alignment, and safety of attachment. Cutouts in the doorjamb for the strikers of the door mechanism are inspected for correct size and condition. The installation of striker plates is checked with respect to the material of the striker plates, their cutout coordinating with that in the doorjamb, and safety of their installation. Striker-plate installations are checked for compliance with finish specifications. Any emergency release provisions installed in the doorjamb or its immediate vicinity are inspected in detail for compliance with all blueprint requirements. The safety of their installation and operation must be definitely established.

32.6. Inspection of Installed Doors. The task of inspecting installed doors, hatches, and enclosures is a responsible one and must be conducted with reference to blueprint information. Inspectors observe the fit of doors and check for uniform and correct clearance between door and doorjamb. The contour of the door in the closed position is checked for proper coordination with the contours of adjacent surfaces. The manner in which sealing provisions fit the installation is noted; these provisions should be of neat appearance and under uniform compression.



Detail of door installation. Note window in door, special locking provision at right of door, and emergency release installation at left of door. (*Courtesy of Douglas Aircraft.*)

32.7. Door-locking Mechanisms on Installed Doors. Inspectors pay particular attention to the door-locking mechanisms on installed doors. They operate them and observe whether or not any part shows strain or buckling due to misalignment or incorrect adjustment. They also note whether or not unusual physical force is required to open or close the mechanism. Correct functioning of the door-operating mechanism is essential.

32.8. Safety of Door Installations. Close attention is given the safety of a door installation. Inspectors check to see that attaching points are secure, that no cotter pins are omitted, and that door-mechanism strikers penetrate striker plates and cutouts sufficiently far. They check strikers for correct alignment with their cutouts in the doorjamb and note the tension on the closed door required to prevent unlocking due to vibration. Any doubt regarding the safety of a door installation must be referred by the inspector to his immediate superior.

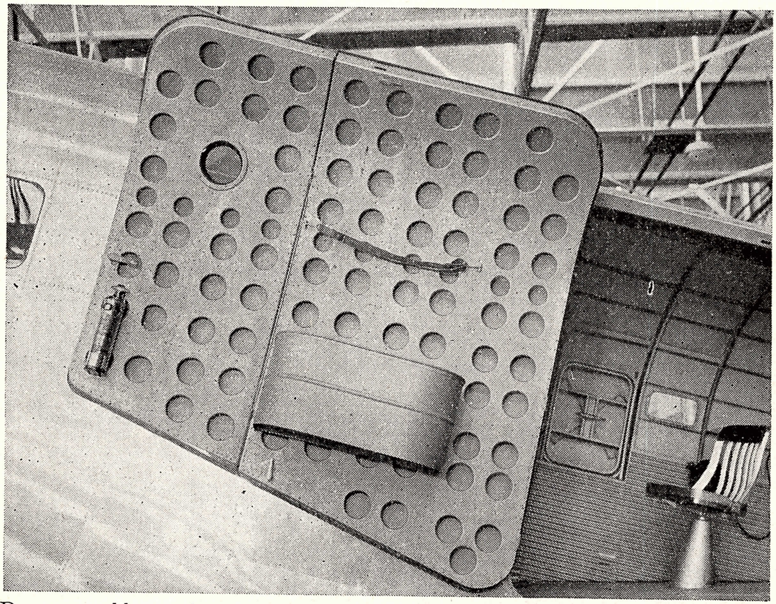
32.9. Emergency-release Provisions. Emergency-release provisions are checked in detail and with care. Their importance is self-evident, and their correct functioning in case of emergency is essential. Emergency-release provisions must be checked for operation. Inspectors note the physical effort required to operate the release, and they should observe closely whether the release is free or whether it sticks or binds. Compliance with blueprint information is required to ensure correct functioning of the emergency-release mechanism. When information such as "Emergency Exit," is required, this is to be clear and legible. The surface upon which this information is painted is of a bright red color.

When engineering requirements specify a certain method of safetying for emergency-release mechanisms, inspectors must make certain that installed safety provisions comply in every detail with the requirements. This is very important. An incorrect installation will endanger the operation of the emergency-release mechanism.

32.10. Water-drain Provisions on Doors, Hatches, Etc. Where provisions for draining water from a door, hatch, or enclosure are required, they are inspected for compliance with the blueprint. The inspector should be sure that no obstruction exists which will prevent proper drainage and that the installation is satisfactory and safe.

32.11. Bonding Provisions. Inspectors should check to see that bonding specifications for door installations are complied with. Particular attention is given the bonding provisions with regard to their possible interference with the operation of the door, hatch, or enclosure on which they are installed. They are checked for correct size, length, and safety of attachment.

32.12. Windows. The inspection of window installations requires careful attention to all blueprint details, specifications, and accepted aircraft standards of workmanship. The safety required in these installations is self-evident. Window installations may be divided into two groups, *viz.:* stationary window installations; and movable, or operative, window installations.



Door assembly on ship. Note that door is in two parts. (*Courtesy of Douglas Aircraft.*)

Two kinds of window material are used, safety glass and plastics. Inspection of windows may be conducted as outlined below.

A. Stationary windows.

1. Safety-glass windows:
   - *a.* Condition of glass, free from scratches, no internal defects, and clear.
   - *b.* Contour of glass, if required, matching contours of adjacent surfaces. Contour even, smooth, and not wavy.
   - *c.* Fit of glass in window channels, glass properly centered.
   - *d.* Condition of channel felt or rubber installation in window channels, felt or rubber not buckled, wrinkled, loose, or damaged.

- *e.* Condition, security, and safety of glass installation.
- *f.* Condition, security, and safety of glass-retaining provisions.
- *g.* Condition and color of protective paint finish satisfactory and in compliance with specifications.
- *h.* Cleanliness of glass.
- *i.* Safety of entire window installation.

2. Plastic-material windows:
    - *a.* Condition of plastic material, free from scratches, distortion, internal defects, or cracks.
    - *b.* Fit of plastic material in window frame, properly located and centered.
    - *c.* Sufficient material within retaining channels.
    - *d.* Holes or cutouts in plastic material of correct dimensions to permit expansion or contraction of material due to changes in outside-air temperatures.
    - *e.* Weather sealing provisions in accordance with applicable specifications.
    - *f.* Retaining channels secure, properly fitting, and installed safely.
    - *g.* Retaining channels not overtightened; correct tension is essential to permit expansion or contraction of plastic window material.
    - *h.* Contour of plastic window matching contours of adjacent surfaces.
    - *i.* Retaining provisions finished according to the finish specifications.
    - *j.* Security and safety of entire window installation.

B. Movable, or operative, windows (those, which can be opened, partly or completely). These installations are inspected and checked for all points enumerated previously. They are checked in addition for the following points:

1. Compliance in detail with blueprint requirements.
2. Ease of operation; physical effort required to open or close the window.
3. Condition, security, and safety of window-operating or -locking mechanism.
4. Sufficient and safe clearances near operating mechanism.
5. Absence of sharp corners or edges on mechanism that might cause injuries to the personnel of the airplane.

6. Security and safety of partly open window.
7. Provisions locking window in a partly open position operating properly and securely.
8. Range of window movement in accordance with engineering requirements.
9. Security and safety of window in closed position.
10. Seal of window in closed position.
11. Window stops, if called for, located correctly, in accordance with blueprint information, secure, and safe.
12. Stencils or other information located correctly, according to the blueprint, clear, and legible.
13. Absence of paint on bearing or rotating surfaces.
14. Paint finish on installation as required in finish specifications.
15. Security, proper operation, and safety of entire window installation.

32.13. Conclusion. The importance of correct operation and safety of door, hatch and enclosure, and window installations cannot be overemphasized. It is a known fact that extremely strong forces act upon the outside of doors, etc., and that installation must be safe under all conditions. Correct operation of doors is very essential, particularly so in an emergency. The safety of doors, hatches and enclosures, and windows is one of the responsibilities of the inspector.

CHAPTER XXXIII

FINAL INSPECTION OF ELECTRICAL INSTALLATION

33.1. Introduction. The great amount of electrical equipment in the modern airplane requires careful inspection to ensure its correct and safe functioning. Complete and detailed inspection is of great importance. Only by inspecting and checking every small detail is safety ensured. Blueprints, specifications, and approved shop practices are to be the authority on which to base the inspection of electrical equipment and its installation. Compliance with accepted aircraft standards of workmanship is essential. Inspectors charged with this inspection must be familiar with all details of blueprints and wiring diagrams in order to carry out their assignments successfully. The following discussion is generally applicable to aircraft electrical equipment and its installation and is offered as a guide to electrical inspectors.

33.2. Open-wire Installations. During inspection of open-wire installations, inspectors should check the surface condition of wire insulation. They should see whether or not the protective covering is damaged at any place or wires are exposed to the possibility of damage by vibrational contact. Wires must be clean and free from foreign material clinging to the surface of the wire covering. Where specifications call for wires to be held together, the installation of such provisions is checked for detailed compliance with the specifications. The color coding of wires must be checked (inspectors should make every effort to become familiar with information regarding color coding). Installation of wire-number bands is to agree with requirements and be satisfactory with respect to standards of workmanship. The type, size, and material of wire terminals and their attachment to wires are closely checked for compliance with blueprint requirements and safety of attachment. The condition of the wire sleeves near terminals is inspected for appearance and evidence of unsatisfactory conditions such as dirt, cracks, or breaks. The safety of an electrical system depends on the condition and safety of its wires. Inspectors should pay close attention to all requirements applicable to electric-wiring installations.

33.3. Electric Junction Boxes. Electric junction boxes should be carefully checked and inspected for interior cleanliness. It is essential that boxes be free from loose metal shavings or other foreign material. They must present a neat and clean appearance.

33.4. Wire Connections inside Junction Boxes. Wire connections inside electric junction boxes are inspected for proper alignment with their terminal posts and for safety of connection. They are also checked for correct tightness (they should not be overtightened) and for the presence of lock washers or locking nuts.

33.5. Clearances at Wire Terminals. Inspectors should check clearances between wire terminals and adjacent metal surfaces and note the radii over which wires must be bent to make a terminal connection within the junction box.

33.6. Wire Identification. Wherever possible the numbers printed on the bands on wires to facilitate the tracing of circuits should be clearly visible.

33.7. Small Parts Used on Connections. Small parts used on connections, such as studs, washers, and nuts, are checked for type and kind of material. Inspectors should note whether they are to be left without a protective coating such as plating or whether such coating is specified.

33.8. Protection for Wires in Junction Boxes. Wiring installations in electric junction boxes are checked for protection from vibrational contact where the wires pass through openings in the boxes. Such protection is to conform in respect to material on method and procedure of installation to specifications issued by factory authority.

33.9. Electric: Conduit Installations. Where wires pass through conduits, the conduits are inspected for safety of installation, alignment of conduit connections, lubrication used as specified, and connections (not overtightened).

33.10. Electrical Controls. Electrical controls such as switches, rheostats, and the like are visually checked for conditions and appearance. They must be replaced if damaged. Safety of installation is essential. They are also checked for operation and range of movement. Lettering on switches or other similar controls is inspected for correct position and location; it should not be chipped or poorly painted. Switches provided with luminous buttons are checked for the presence of such buttons. Clearances are noted in the vicinity of electric controls to ensure safe and proper functioning. Wiring connections to such controls are inspected for safety and cleanliness. Correct alignment and safe clearances with adjacent installations or surfaces are important, particularly so if a large number of connections are located in a small area. The correct degree of tightness is essential to the safety of electrical connections.

33.11. Electric Circuits. Electric circuits are checked by factory-approved methods for continuity, grounding, and short circuits. Wiring diagrams are used as guides in making these checks. It is important for the numbers on the number bands located next to the wire connections to agree with the numbers given on the wiring diagrams.

33.12. Light Installations. Light installations are inspected and checked for compliance with blueprint requirements and other specifications. It is important that inspectors check the specifications affecting the voltage of bulbs. The condition of light sockets and the safety and security of bulb installation are important. Reflectors, if used, are inspected for satisfactory surface condition and brightness. The condition, fit, and safety of glass installations are inspected with care. Weather sealing provisions are checked for compliance with the specifications and for appearance. If glass is colored as on passing or formation lights, it is checked for correctness and condition of the color. It is important that all light installations be carefully inspected for safety, especially lights installed on outside surfaces, such as passing, formation, or landing lights.

33.13. Landing Lights. Landing lights are very important and require careful inspection. If such lights are retractable, they are closely checked for proper operation. Range of movement is important, for certain degree settings are specified for the extended position. Inspectors should note the time required for full extension and retraction and check this with the specifications. When light is retracted, inspectors check required clearances between the light and adjacent surfaces, also the coordination with surrounding contours. The outside surface of the light must be even with surfaces surrounding it when it is in the retracted position. Any adjustments necessary are to be made according to authorized specifications.

33.14. Electric Units. Electric units such as dynamotors are inspected for safety of installation. Vibration shock-absorber installations are checked for compliance with blueprint requirements. It is important that shock-absorber units of the correct type, size, and material be used. Clearances of such units with other parts or installations in their immediate vicinity are inspected. The installation of safety wire at base connections is checked for material of wire used and for compliance with accepted aircraft standards of workmanship.

33.15. Electric-fuse Installations. Installations of electric fuses are inspected for compliance with blueprint and technical requirements. The clip holders of fuses should be securely attached and the holder units properly aligned and undamaged. Fuses themselves are checked for type, size, and installation. Surfaces of fuses are inspected for cleanliness where they come in contact with fuse holders. Fuses must lock securely in position on fuse holders and must fit such holders.

33.16. Installed Wiring Diagrams. Specifications calling for installations of wiring diagrams in specified locations are checked for compliance. Particular attention is given the identifications of such diagrams. They must correspond to the actual wiring installation they represent. Inspectors should check identification of wires as given on a wiring diagram with the identification numbers on the number bands installed on wires. Wiring diagrams either are located in the immediate vicinity of connections they show or are commonly found on the inside of the junction-box covers. The installation of wiring diagrams is given in specifications which must be complied with. Inspectors are to check for compliance with installation specifications and for the appearance and condition of installed wiring diagrams.

33.17. Covers on Junction Boxes. Covers on junction boxes are inspected for correct fit and appearance. The means of fastening the cover to its box are checked for operation, alignment, fit, and general condition. The type, size, and material of fasteners are checked for compliance with blueprint requirements. It is important to see that the cover, or lid, makes uniform contact with the box in order to provide proper bond and shielding of the wire connections within the box.

33.18. Flexible Conduits. Flexible conduits are inspected for good condition and lack of damage. Alignment of connections is important, and the radii over which a flexible conduit is bent are observed. Flexible conduits must not be bent over too short a radius. Where it passes through conduit supports the installation is checked for alignment, fit, and protection of the flexible conduit. Bonding provisions and their installation are checked and inspected for security and compliance with the specifications.

33.19. Bonding Requirements for the Electrical System. The entire electrical system and its installations are inspected and checked according to all bonding specifications issued by factory authority; compliance is essential. Inspectors should make certain that bonding is acceptable and satisfactory.

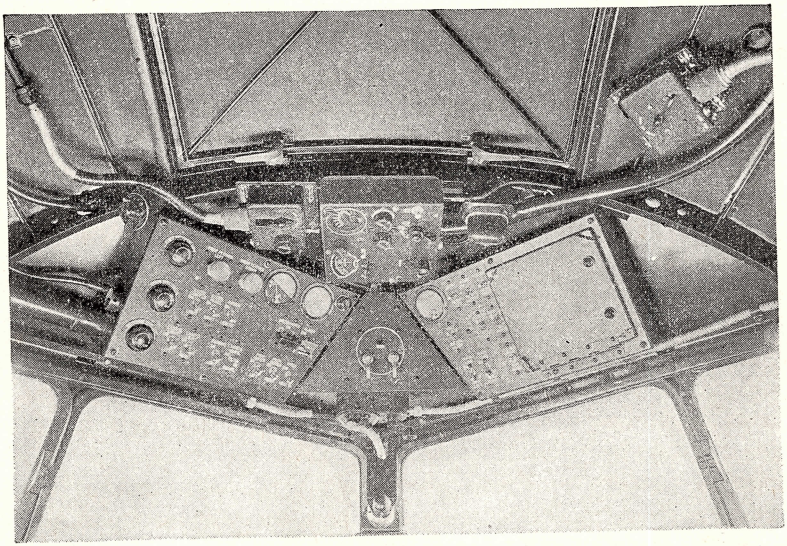
33.20. Radio Equipment. Radio equipment and its installation are inspected and checked like the electrical equipment. In addition, the radio units themselves are checked, operated, and tested according to manufacturer's instructions and information. Radio inspectors must be familiar with such information and any other factory-authorized specifications regarding method and procedures to be followed during inspection of radio units and their installation or operation.

33.21. Antenna Installations. Inspectors must check antenna installations in detail, according to blueprint information. Particular attention should be given the tension imposed on antenna wires. Clearances must be satisfactory at points of wire attachments. Where springs are installed on antenna wires, the installation is checked closely for safety of attachment. The entire antenna system of the airplane is inspected and checked for compliance with technical specifications as shown on blueprints, standards of workmanship, and safety of installation.

33.22. Bonding Provisions. Of great importance is the correct and satisfactory bonding of radio units and their installation. Bonding provisions are required across vibration shock-absorber units. Inspectors should check these provisions for type, size, and safety of installation.

33.23. Insulators and Their Installation. Insulators and their installation are inspected for compliance with blueprint requirements. Insulators are checked for type, kind of material, size, and number. They are also checked for condition, appearance, and safety of installaton.

33.24. Radio Remote-control Units. Radio remote-control units are inspected for correct installation and alignment of connections. Connections should not be overtightened, for this will endanger the operation and safety of the remote-control transmitting provisions. Flexible control shafts, if used, are checked for proper routing; such shafts should not be installed over too short a radius bend. Coordination and synchronization are checked between indicated positions on both units, the remote-control unit and the radio unit itself. During the operation of the remote-control unit, inspectors should note any bind during the range of movement and whether or not the indicated positions match each other. Any slippage of control or unusual "rubbing" noise heard either in the units or in the flexible-shaft connection should be checked. Remote-control units and their installation are inspected for compliance with blueprint requirements and specifications, correct direction and proper range of movement, ease of operation, coordination of indicated positions, general appearance, and safety of units and their installations.



Electrical and radio installations in the pilot cockpit. Note remote-control units of radio equipment. (*Courtesy of Douglas Aircraft.*)

33.25. Special Types of Antenna. Radio units such as trailing antennas and retractable-loop antennas and their installations are inspected in detail for compliance with blueprint requirements. Safety of their installation is important. Clearances and fit of such units in their positions must be checked. Inspectors should note any indications of unsatisfactory conditions during test operations. The units must not bind or touch other installations during the entire range of movement. Electrically operated units are checked for correctness of direction. Safety of units in their extended position is important. The units are also checked for safety while in the stowed, or retracted positions. The safety of holding and locking provisions is essential.

33.26. Intercommunication Systems. Intercommunication systems such as interphones, lights, or bells are checked for proper functioning. They are tested a number of times to make sure that they operate correctly, dependably, and safely.

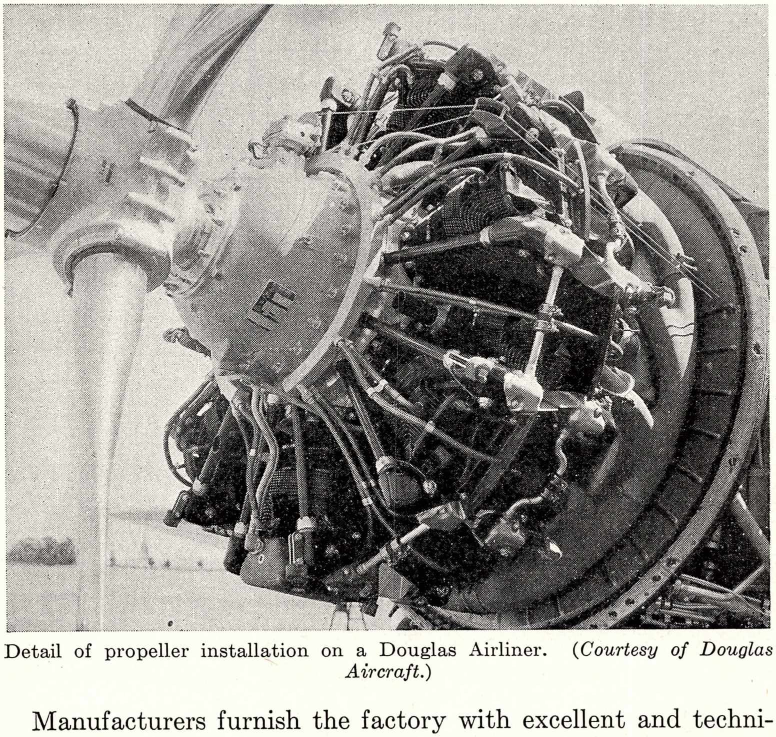
33.27. Battery Installations. The battery compartment is checked for general condition, cleanliness, and safety. It is also inspected for compliance with special requirements, applicable to battery compartments such as those specifying a coat of acid-resisting paint, etc. The battery installation is inspected for security and safety. Battery connections are checked for tightness, alignment, condition, and safety. When specifications call for a protective coating on terminals, these are checked for compliance. Battery venting provisions are checked for condition, freedom from internal obstructions, and safety of installation.

33.28. Conclusion. Inspectors checking the electrical and radio systems of the airplane are responsible for the correct, dependable, and safe operation and function of these systems. Whenever they are in doubt about any condition found during inspection, they should contact without fail their immediate superior. Safety must never be compromised.

CHAPTER XXXIV

INSPECTION OF POWER PLANT IN FINAL ASSEMBLY

34.1. Introduction. When the airplane reaches the final-assembly department, the power plant, cowling, and controls are carefully inspected and checked to ensure that the power plant is ready for field operations.



Detail of propeller installation on a Douglas Airliner. (*Courtesy of Douglas Aircraft.*)

Manufacturers furnish the factory with excellent and technically correct information on procedures and methods of propeller installation and inspection. Excellent books are available, treating the subject of aircraft propellers extensively. Final-assembly inspectors assigned to power plants are advised to consult these sources. The discussion of propeller inspection in this chapter will deal with inspection of installed propellers only.

34.2. Inspection Procedure for Power Plant. Inspection of a power plant should be accomplished in a systematic manner. The order of inspection is as follows:

1. Propeller installation.
2. Engine (cylinders, ignition, etc.).
3. Accessory section.
4. Firewall.
5. Engine mount.
6. Various controls in engine section.
7. Accessory doors and sections.
8. Antidrag ring before installation.
9. Antidrag ring after installation.
10. Complete cowling installation.

34.3. Propeller Installation.

1. Propeller dome.
    - *a.* Condition of dome surface. Inspectors check the surface of the propeller dome for nicks, scratches, or other damage. It is important that the surface be clean and smooth.
    - *b.* Condition of safety. The safety is checked for locking ring in plug located in nose of dome. (This applies when engine does not breathe through engine crankshaft.) Also, inspectors check the safety-wire installation on screw that prevents the dome from loosening up.
2. Propeller blades.
    - *a.* These are inspected for scratches, nicks, or dents.
    - *b.* The identification of blades is checked for condition (it must be legible) and is compared for correctness with records of inspection previously made.
    - *c.* Indexing marks of degree setting are checked closely; inspectors must note particularly the indicated alignment.
3. Slinger ring and de-icer equipment.
    - *a.* These are checked for sufficient and safe clearances. De-icer tube outlets are checked closely for clearance when propeller blades move to full feathered position.

   b. Direction of de-icer tube outlets is noted and checked for proper and correct setting.

   c. Condition of de-icer tubes is inspected. They must not be dented, kinked, or flattened, and their opening must not be obstructed in any way.

   d. Flexible hose connections on the de-icer tubes are checked for alignment and security of attachment. Hoses must not be twisted, damaged, or kinked or otherwise be in an unsatisfactory condition. Close attention is given the safety of their installation.

4. Propeller governor.

   a. Inspectors check the safety of attachment. Condition, material of safety wire, and its proper installation are observed closely.

   b. Careful inspection is given the safety of adjusting provisions. These must not be damaged or unsatisfactory for whatever reason.

   c. Safety of the governor control pulley and its installation is noted. The cotter pin must be neatly and correctly installed.

   d. Inspectors carefully check the condition of the governor control cable and its alignment with the pulley. Particularly close attention must be given the cable where it is secured in the governor control pulley. It must not be damaged or secured only partly. The safety of the cable secured in the pulley must be unquestionable.

   e. Inspectors are to check carefully the freeness of movement when the propeller governor control is operated. It should not bind or feel unusual but should be smooth and steady in action.

34.4. Engine.

1. Condition of cylinder fins is inspected for damage and alignment of fins. They are checked for cracks and bent or broken surfaces. The spaces between the fins must be clean and free from obstructions such as pieces of tape.

2. Safety of cylinder attachments is important. Inspectors must inspect such attachments carefully and in detail.

3. Clearances between cylinders and adjacent surfaces are checked to see that they are sufficient and safe.

4. Safety of valve covers is checked. Close attention is given the covers for possible cracks in material caused by uneven tightening or overtightening. The sealing gasket is given an exterior visual check for fit and condition.

5. Condition of the ignition harness is noted. It should not be damaged or dirty. Where supports are installed, they are checked for proper fit, alignment, and security. The ignition harness should be properly identified, and its identification should be compared with the records for correctness.

6. Spark plugs and connections are inspected for condition, tightness, and safety. It is important that connections be undamaged and tight.

7. Thermocouple connections are checked for damage, proper support, and security. They are inspected for clearances or kinks along their installation.

8. Baffle plates are inspected for condition, clearances, and safety.

9. Careful inspection is given the installation of the collector ring and its component parts. Inspectors check and observe condition, safety, tightness, freeness of collars, and the safety of segment connections.

10. The safety of the engine-section diaphragm is important. It is inspected for fit and condition. Inspectors note the safety of the diaphragm attachments.

11. Clearances between diaphragm and adjacent surfaces or installations are checked. They must be sufficient and safe at all points.

12. Safety of engine dynamic suspension provisions is checked. They are inspected for installation of cotter pins, and inspection records are checked to ascertain that torque checks have been made.

13. Clearances of fitting bosses near base connections on dynamic suspension points are important. Inspectors should check for these carefully.

14. Rubber of the dynamic suspension provisions is given a visual check for condition.

15. Antidrag-ring support installations are inspected for condition, clearances, proper contours, and safety.

16. Motor mount where the engine attaches is closely inspected for damage, and possible cracks at gussets or in corners.

17. Protective finish on the motor mount is checked for condition and compliance with finish specifications.

18. Where Dzus springs are installed, they are checked for condition, alignment, and safety.

19. Material around Dzus fasteners is inspected for cracks or other unsatisfactory conditions.

20. Inspectors inspect and check condition, fit, location, and safety of any antirubbing material such as is installed on antidrag-ring supports.

34.5. Accessory Section.

1. The carburetor. Inspectors check the installation of the carburetor and its safety, condition, and alignment. It is important to note particularly the alignment of carburetor control connections and their safety. There must be sufficient and safe clearances between the carburetor, its controls, and adjacent surfaces or installations. Inspectors check for correct travel of controls, freeness, binding, or interference during operation of carburetor controls *except the throttle control,* which remains safety-wired in its closed position. This safety wire and its seal are checked. The carburetor intake scoop is checked for cleanliness and freedom from any loose or foreign material. Carburetor temperature-bulb installation is checked. It is necessary visually to inspect all sealing gaskets for condition and proper alignment with the surfaces between which they are installed. If a record of the identification of the carburetor has not been made, inspectors do this.

2. The generator. The generator is inspected and checked for condition, safety of the unit, and its installation. Electrical connections are checked for proper installation, tightness and alignment of connections, alignment, and safety of conduit supports, and installation and safety of generator blast tubes and for compliance with accepted standards of workmanship.

3. The starter. Inspectors check the starter for condition and safety of installation. Electrical connections are inspected for proper alignment and installation, tightness, and safety. Supports located on conduits are checked for alignment, size, fit, and safety of installation. Where provisions are installed for hand cranking, they are inspected for condition, alignment, and safety of their installation. The hand crank should be tried for fit, alignment, and clearances in all possible hand-crank positions.

4. Various accessories (fuel pump, vacuum pump, oil pump, etc.). These are inspected and checked for safety of installation, clearances with adjacent installations, safety of attachment, and condition of units. Attachment, clearances, safety, and possible movement of any tubing connections are checked. The installation of tubing connections is inspected for compliance with accepted aircraft standards of workmanship.

34.6. Tubing Installation in the Accessory Section.

1. Tubing. Tubing is inspected and checked for condition and appearance; it should not be damaged by scratches, nicks, or dents or flattened at radii bends. Inspectors should note how clamps are installed, the fit of clamps on tubing, security and safety of these supports, clearances with adjacent installations, and provisions against vibration, such as tubing ties. Threaded connections of tubing installations are checked for alignment, tightness, and required lubrication. The specified identification color banding on tubing is checked for correct color, location, and appearance. Inspectors must make certain that the color identification is definitely correct for the system it represents, such as the fuel, oil, hydraulic, vacuum, de-icer, fire-extinguisher, and steam systems.

2. Conduits. These are visually inspected for condition of surface. They should not be dented, nicked, scratched, or flattened at radii bends. Their bend radii should correspond to authorized information concerning ratio of radius to tubing material. Inspectors note the alignment and security of supporting clamps. Connections are checked for compliance with standards of workmanship. Flexible conduits are inspected for frayed shielding, condition of clamp protection, installation of bonding braids and their safety. Inspectors note the bends of radii over which flexible conduits are installed and attention is given that the bends are within authorized specifications affecting flexible conduit bend radii. Clearances in the vicinity of flexible conduit installations is observed as it is important that the conduit does not chafe at any place. Where ends of flexible conduits connect, the connections are checked for condition, alignment, security, tightness and safety.

34.7. Control Cables of Power-plant Installations. They are carefully gone over in detail. The inspectors check and inspect for compliance with blueprint requirements and the specifications. The cables are checked for frayed or broken strands, kinks, and dirt. Tension and identification banding, condition of cable serving, and cable ends and their connections are inspected with care for compliance with specifications and to ensure their safety. Lubrication is checked on cables and threaded connections.

Turnbuckles and their safety, number of threads exposed (three threads exposed on each side of the turnbuckle barrel is the maximum number permitted), and condition are checked closely. Inspectors should refer to blueprint requirements during control inspection and should ascertain that turnbuckles of the correct type are used, for example, turnbuckles having short or long barrels and a given load capacity. Turnbuckles must be staggered correctly in relation to each other; inspectors should note this particularly while controls are operated. It is important to the safety of the controls that no turnbuckle or parts of its connections touch on pulleys, fairleads, cutouts, or adjacent installations. Sufficient clearances must exist when control cables and connections are exposed to vibration.

34.8. Pulleys and Fairleads in the Power-plant Control System. Pulley supports are inspected closely for cracked material, alignment, and safety of installation. Pulleys are checked for cracks, warping, or other unsatisfactory conditions. Inspectors are to make sure that pulleys of the correct type and size are used, referring to the blueprint for correct information. Pulley installations are inspected and checked for safety of the pulley center-bolt installation and clearance between pulley and pulley support and pulley and cable guard. Safety of the cable guard is checked. Inspectors should note the alignment of the control cable with the pulley groove; any misalignment is checked for established and approved limits and tolerances. Should any doubt exist as to the misalignment of cables, inspectors should consult their immediate superior. During the operation of control, inspectors must see that the pulleys rotate; this is important and required. During operation, inspectors must observe whether or not pulleys have clearance between the sides of the support in which they are installed. If there is no clearance at a certain point, the condition must be corrected.

Fairleads are checked for condition, correct installation, and safety. Clearance between fairlead cutout and cable is noted, and the cutouts and entry slots are closely checked for damage or cracks and for compliance with blueprint specifications. A correct cable-entry slot in a fairlead will prevent the cable leaving the fairlead under any condition.

Inspectors are to note any angular misalignment of cable and fairlead. Angular alignment is to conform to authorized specifications, limits, and tolerances. Questionable conditions must be brought to the attention of one's immediate superior.

34.9. Hose Connections in the Accessory Section. Hose connections are checked for type, length, and kind of material. The safety of their installation is very important. Where tubing ends are beaded for the installation of a hose connection, inspectors should note particularly the location of hose clamps. They should also make sure that the ends of rigid tubing do not touch within the hose connection. Installation, condition, and safety of hose connections are checked. It is important to note that on the pressure side of the engine oil system a double set of hose clamps is required.

The condition, alignment, location, and tightness of hose-clamp installations are observed. Particular attention must be given the radii of clamp band guides which may be cracked owing to tightening of the clamp. Clearances between hose connections and adjacent surfaces or installations are checked; they should be sufficient and safe.

34.10. Relief, or Check, Valves in the Accessory Section. Relief, or check, valves are closely inspected for condition, alignment, and safety of installation. Of particular importance is their correct installation, particularly in regard to proper direction of flow of liquid. For this reason, inspectors should refer to blueprint information to ensure correct installation. These units may have arrows on the outside, the arrow indicating the direction of the internal flow.

34.11. Firewall. The power-plant firewalls are inspected for condition and appearance. Since firewalls are made of stainless steel, still, caution should be exercised in bringing dissimilar metals in contact with them; the specifications may be consulted on this point. Safety of installations on firewalls is carefully checked, also clearances between installations of the various units attached to the firewall. Cutouts are checked for installation of provisions designed to prevent fire from coming through them.

Reference to the blueprint is necessary to ensure the safety of the firewall and its installations.

34.12. Engine Mount. The installed engine mount is closely inspected and checked. Inspectors check the safety of mount attaching-bolt installations. When castellated nuts are used, they are inspected for installation of cotter pins. On bolts installed into trunnions, the safety installation is safety wire. Its installation is checked for correct material and size and conformance with accepted aircraft standards of workmanship.

Bonding provisions installed at the mount attachment are checked for condition, proper size, length, and safety of installation.

All welds, corners, and gussets are carefully inspected for cracks or other unsatisfactory conditions. The condition of the protective finish or coating is observed.

Clearances are checked between engine mount and various installations. Such clearances should be inspected with the possibility of vibrational contacts in mind.

34.13. Various Controls in Engine Section.

Inspectors check the cowl-flap hydraulic controls closely and carefully for clearances, safety, and leaks at the actuating cylinder or tubing connections.

During operation of these installations, inspectors watch for clearances of the actuating mechanism, particularly where actuating rods pass through cutouts. The speed with which cowl flaps open or close is observed. It is noted whether the speed and movement of opening and closing flaps are the same (on twin-engine airplanes) on both engines or synchronized as closely as possible. The degrees of opening are checked; they must conform to engineering specifications.

The safety and correct tightness of actuating-rod connections are checked. This includes checking and inspecting locking nuts, cotter pins, and thread penetration to inspection holes on rod ends. Inspectors note whether any individual flap units have unusual play in their connections or show evidence of binding at their base connections. When cowl flaps are closed, it should be noted if they coordinate in regard to contour alignment and also if antifriction provisions have been provided on overlapping surfaces of flaps. The cowl flaps are checked individually for condition; edges should be smooth, and radii of corners satisfactory.

Inspectors should check the correct direction of movement as indicated by certain positions of cowl-flap actuating controls in the cockpit. Color identification on flap control handles is checked to specifications. Security of control installations in the cockpit is inspected carefully, and it is made certain that safe clearances exist between control handles and adjacent structures or installations. Only after definitely establishing the safety of engine cowl-flap operation and installation are inspectors to accept them.

34.14. Tubing of Cowl Flaps and Installation. Tubing in the hydraulic system of cowl flaps in the engine section is inspected for

1. Surface condition (scratches, nicks, dents, flat spots, and correct diameters at bends).
2. Alignment, tightness, condition, and lubrication of tubing connections.
3. Identification (correct color, location, and appearance).
4. Correct size, type, material, fit, alignment, and tightness of tubing supports.
5. Bonding (conforming to authorized procedures and approved tolerances).
6. Provisions for prevention of excessive vibration, such as lacings (effectiveness, kind of material, and installation according to specifications).
7. Clearances (sufficient and safe between tubing and adjacent surfaces or installations).

34.15. Engine Controls. The correct, dependable, and safe operation of engine controls is essential, and their importance self-evident. In the final-assembly department a thorough inspection is made.

1. Inspectors check cables for frayed or broken strands, kinks, lubrication, and dirt.
2. Controls are inspected for correct type of cable turnbuckles, lubrication of threads, and number of threads exposed at either end of turnbuckle. Three threads exposed at either end is the maximum allowed. Inspectors check for type and size of safety wire used; the manner of safetying should comply with specifications and approved practices. The condition of the cable serving is inspected, also the identification banding for compliance with the specifications.

3. Where control cables connect to units such as carburetor, starter, or supercharger, these connections are checked carefully for safety, freeness of movement, clearances, and proper and correct travel as to amount and direction. Cables must not be twisted. They are checked for compliance with technical requirements regarding angular alignment with their respective pulleys. Pulleys in the control system must be free from damage, warping, or other defects and are checked to see that they do not rub against the sides of the supports. Clearances between the pulley and the sides of the support and at the cable guard are noted by inspectors. During operation, they should observe whether or not the pulleys rotate as required. The safety of the pulley center bolt installation is checked, also the safety of the cable guards.

4. It is necessary that the controls in the pilot's cockpit coordinate with required movements or stops of the units they connect with in the engine section. The tension of engine control cables is checked for compliance with the specifications. The proper tension is very important.

5. Where cables pass through cutouts, they are checked for clearance. Inspectors should see that cables are protected from rubbing by proper and authorized provisions. Such provisions are checked for compliance with blueprint requirements and for safety of their installation.

6. Spacing of cable turnbuckles is checked. Inspectors should note how close turnbuckles come to each other, to control pulleys, to fairleads, or to sides of cutouts and whether or not there is a possibility of the turnbuckles whipping against each other while the engine is running.

34.16. Accessory Doors and Sections.

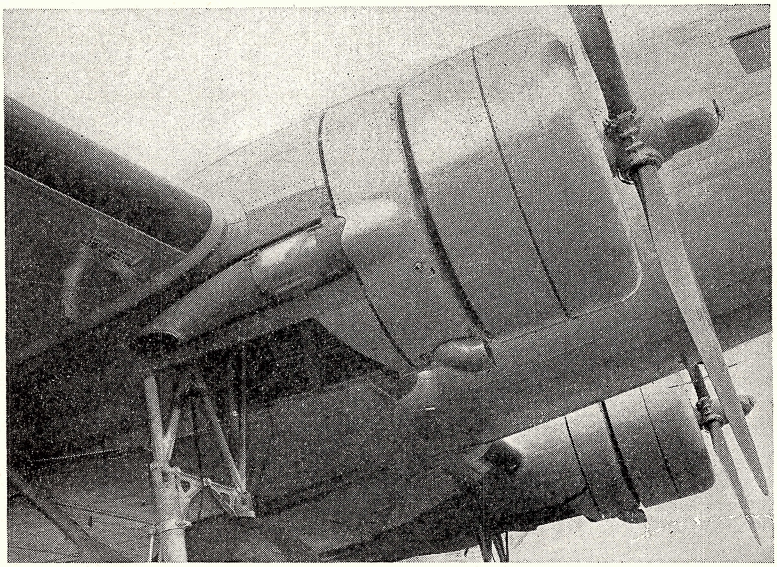
1. Before installation, these units are checked for condition of surfaces, which should be undamaged and satisfactory according to accepted standards of workmanship. Close attention is given areas that have been countersunk or counterpunched. These areas are checked for cracks, depth of countersink or counterpunch (head of fastener must seat flush), and the edge distance at these locations.

2. The supporting structure to which the doors or sections attach is checked for safety. The attachment of Dzus fastener

springs are inspected for security and compliance with aircraft standards. The springs are checked for position and alignment.

Spot welds are visually checked for condition and appearance. If any doubt exists as to their safety, one's immediate superior should be consulted.

3. During installation of doors, inspectors should observe their fit and the alignment of fasteners with their respective attaching locations. Clearances are noted between doors and adjacent parts, and their installation is checked for safety. The safety of the doors themselves and their installation are most important. Particular care should be taken to see that Dzus fasteners lock correctly and sufficiently.



View of engine-cowling installation. Note the de-icer boot installation on the leading edge of the wing. (*Courtesy of Douglas Aircraft.*)

34.17. Antidrag Ring before Installation. It is extremely important that this unit and its component segments be inspected with great care. Inspectors should check the condition of interior pads, their workmanship, and the safety of the installation. The trunnions, their threads, and the safety of the installation are inspected. They must conform to blueprint requirements for material, type, fit, and attachment. The outer surfaces of the antidrag ring should be free from scratches, nicks, dents, and other similar damage. All corners of reinforcing channels, stiffeners, etc., are checked closely for possible cracks or other unsatisfactory conditions. It is important that the safety of this unit and its component segments is definitely established.

34.18. Antidrag Ring after Installation. Inspectors check the antidrag ring after its installation on the engine for:

1. Fit of assembly. Correct fit is essential. Inspectors check for uniform seating on supporting structure.
2. Amount of pressure on leather pads. Leather pads should exert an even pressure on cylinder heads and should not be offside.
3. Installation, tightness, and safety of locking trunnions. It is important that the adjustment of trunnions be correct. Inspectors must be familiar with authorized information on and methods affecting the correct tension of these trunnions. The safety of trunnions is checked after installation.
4. Supports. Where design specifications require additional supports or attachments of the antidrag ring to its supporting structure, inspectors are to check these in detail for compliance with the blueprint and safety of their installation.
5. Clearances. Inside and outside clearances are observed. Inspectors should check clearances between the forward end of the antidrag ring and the engine propeller in all positions.
6. Segment attachments. The security and safety of segment attachments are important. Inspectors should check these in detail and carefully.
7. Matching of contoured surfaces. It is necessary that all contoured surfaces coordinate with adjacent contoured surfaces and that symmetrically they be satisfactory.
8. Bonding. This is checked for compliance with the specifications.
9. Paint. Specifications calling for antiglare paint are consulted to see that the areas so painted are the correct ones and that the proper color has been used.
10. Safety of installation. The importance of this cannot be overemphasized. When in the slightest doubt, the inspector must consult his immediate superior.

34.19. Complete Cowling Installation. After this installation is accomplished, inspectors check for the following:

1. Clearances between engine exhaust system and antidrag-ring installation. Sufficient and safe clearances are essential.
2. Alignment and coordination of surfaces. It is necessary that such alignment and coordination be satisfactory and acceptable.
3. Clearances at tubing drains. Tubing should not be located offside to the extent of resting against the side of the cutout. Where provisions such as grommets are installed to prevent vibrational contact between tubing and drag ring, they are inspected for condition and safety of installation.
4. Clearances at carburetor installation. It should be remembered that there is a possibility of movement of the engine while in operation.
5. Clearances at engine cowl-flap installations. These are important. They are checked for compliance with safety requirement.
6. Security and safety of all fasteners and doors (if any). Inspectors should check carefully for condition, fit, safe locking, and safety of installation.
7. Skins. These are checked for buckling and "oilcans." The finding of either requires careful research into the causes of the condition. Possibilities are incorrect fit, installation, or adjustment.

34.20. Conclusion. Inspectors should check and inspect the entire power plant with all its parts, units, and installations in such a manner that the dependability, correct and dependable operation, and the *safety* of the entire power plant or power plants is established beyond any doubt. They must see that all requirements as shown on blueprints or given in other engineering information are definitely complied with. Specifications issued by factory authority are important, and inspectors are to make certain that they are carried out. Approved and authorized shop practices, methods, and procedures must be followed, and inspectors should make every effort to become familiar with such procedure. Approved and accepted aircraft standards of workmanship should be well known to all inspectors assigned to power plants. Whenever any doubt exists in the mind of an inspector as to acceptance or refusal, he should without fail consult his immediate superior. The safety of the power plant must never be jeopardized.

CHAPTER XXXV

PREPARATION AND INSPECTION OF ENGINE BEFORE FIRST RUN

35.1. Introduction. Preparation is most important to the safety and correct functioning of an engine run. These preparations are to be carefully watched by inspection personnel. The various operation checks also require thorough inspection.

35.2. Procedure. The required preparations and operations are conveniently classified as follows with respect to engine parts and special procedures:

1. Engine.
2. Fuel tanks.
3. Operation of fuel valves.
4. Operation of wobble pump.
5. Fuel-leak check.
6. Dilution valve.
7. Fuel strainers.
8. Priming of oil-pressure instrument lines.
9. Oil tanks.
10. Hydraulic system.
11. Heating system.
12. Landing-gear shock absorbers.
13. Fire-extinguisher system.
14. Clearing of airplane for engine run.
15. Safety precautions.
16. Propellers.
17. Breather and vent lines.

35.3. Engine and Fuel Tanks.

1. Production personnel will lubricate the valve rocker arm bearings in the valve boxes by pouring on engine oil. The cover is then ready for reinstallation; but before it is actually installed, it is very important that the condition and fit of the sealing gasket be inspected. The covers themselves must be inspected

thoroughly for flaws or any questionable condition in their material. During and after replacement of the cover, inspectors should watch the way in which the nuts are drawn down and how tight, for they should be neither too loose nor too tight. It is very important that the lock washers when called for should not be omitted under the cover hold-down nuts.

2. Inspectors should be present during the breaking of seals on fuel- and oil-tank covers; the compartments must be thoroughly and minutely inspected for any evidence of having been tampered with and for existence of any foreign matter. Oil breather lines must be cleared.

3. The functioning of the engine primer provisions is checked; this is important.

The procedure now is as follows:

a. Disconnect primer line at engine connection.

b. Unlock primer handle.

c. Operate wobble pump, and build up light pressure.

d. Pump primer handle approximately three or four times.

e. Provide basin to catch runoff fluid at open primer line at engine.

f. Note fuel expelled at broken connection.

g. Stop operation of primer handle when fuel shows clean and clear.

h. Note manner of locking of primer pump handle in closed position.

i. Connect primer line previously disconnected.

j. Pump up fuel pressure with wobble pump.

k. Inspect closely all primer-system connections for leaks, particularly behind instrument panel at primer-unit connections.

After the primer check has been found satisfactory, make record entries, signing and dating them.

4. The inspector now removes the throttle seal and safety wire on the throttle controls.

35.4. Fuel Tanks.

1. The first step is carefully to remove the bottom strainers; also, drain the fuel strainers in the system. The removal of these strainers will permit the solvent to drain out. The strainers are inspected for the condition of the screens and type and condition of sealing gaskets. It is very important that all strainer

covers be identified as to location and be painted the correct color; in this case the color is red. The strainers are to be protected against dirt and damage during the time they are removed; they must not be reinstalled unless clean, undamaged in every respect, and properly identified.

2. After the solvent test fluid has drained out, the strainers are reinstalled. The strainers are to be most carefully started in their threads; special tools, if any are required, are to be used in their reinstallation. Inspectors see that the strainers are tight, but not overtight, and that the safety provisions are correct and sound in their position or manner of application.

3. After the above preparations and precautions have been completed, it is very important that before actual fuel is used in the tanks the airplane be "grounded." By "grounding" is meant that a connection such as a lead weight suspended by a chain is usually clamped on the landing-gear units to carry off any possible accumulation of static electricity. This is of great importance; for modern high-octane-rating aviation fuel is extremely volatile, and any spark might have grave results.

4. If, for any reason, a battery cart is attached to the ship, this is disconnected before fuel is put into any tank. This precaution is necessary to prevent any danger of electric sparking due to electric currect present in the system.

5. Before any fuel is brought near the airplane, proper precautionary means are taken to guard against the possibility of fire. The fire-fighting equipment should be sufficient to extinguish a fire quickly and effectively. A large container of carbon dioxide gas carried on wheels for rapid movement is generally on hand. Men assigned to it know how to operate it quickly and efficiently. Hand fire extinguishers are inside the airplane in the various compartments. It is very important that this equipment be fully loaded, checked, and ready for use. The area surrounding the airplane should be clear of all obstructions so that the fire-extinguishing equipment can be moved rapidly to any location outside the airplane. The importance of these precautions is self-evident. Strict compliance with all regulations is asked of everyone.

6. Certain precautions are necessary during the filling of the fuel tanks. The hose used to carry fuel should be lifted over the surface of the wing, not dragged across. The nozzle should

be clean and free from any dirt; it should never be dragged across the ground. The correct octane rating fuel is determined and the proper supply tank connected. During fueling, care should be taken not to spill any fuel, for this will constitute a hazard. Before removing the nozzle, the control on the nozzle must be securely closed so that all dripping of fuel has ceased. The hose is to be handed back to the ground crew carefully so as not to damage it. A proper record is kept of all fuel drawn from the main supply tank.

7. The quantity of fuel required for test run is predetermined. During the filling of the tanks, inspectors should observe the fuel indications on the gages in the pilot's cockpit. Certain safety measures are provided to indicate that fuel in the tanks is low. These should be checked for correct functioning during the first part of the fueling operation, by frequently comparing readings on the gages with the quantity shown on the master gage of the fuel supply tank from which the fuel is supplied to the airplane. It is very important that the quantity of fuel indicated should correspond with the readings of the master fuel gage. Any errors in readings in excess of accepted limits require corrective steps to ensure the definite and reliable fuel readings so vitally important to the pilot.

35.5. Operation of Fuel Valves. Correct operation of fuel valves is essential. During inspection of this installation, the first unit to be checked is the manual control panel in the pilot's cockpit. The handle is turned; and as the ports in the valve body are opened or closed, a distinct resistance, or "click," can be felt. This is very important. In addition, the physical effort required to operate this installation is noted. The operation should not be too hard or too light; a snug and definite movement is required, with no noticeable lag or slack in the controls. The tension on the cables of this installation is checked in the prescribed manner, as well as clearances, alignment, and possible interference during operation. The safety of the entire system is most important. It is recommended that inspectors observe cable travel during operation and note any conditions affecting operation or safety.

35.6. Operation of Wobble Pump. It is necessary that this pump should supply both sides of the fuel system. The test is accomplished as follows: The left-hand system is used while the right-hand system is shut off. By operating the wobble pump, pressure will be indicated on the fuel pressure gage, if the system is operating correctly. The same procedure is used on the right-hand system. It is important to note whether or not the pump is operated the pressure remains constant; if it does, this indicates a correctly functioning wobble-pump installation. During operation, inspectors check the operating links, or controls, for amount of physical effort required to operate the pump. Clearances, range of required movements, and safety of the entire system and its installation are of importance. Thorough inspection will ensure a safe and correct wobble-pump system.

35.7. Fuel-leak Check. To ensure a leakproof system, it is necessary to test by applying pressure. To obtain this pressure, the wobble pump is operated and the pressure held constant for a specified period. After this period the actual inspection is begun for fuel leaks. The check for leaks in the fuel system is carried out systematically. Tubing connections and fuel-system control units require careful observation. It is important to watch for evidence of leakage near enclosed parts of the system. "Sweating" near or around doors, etc., should be investigated. Any trace of a fuel leak must be checked and definitely eliminated before the fuel system will be accepted and signed out as safe for an engine run.

35.8. Dilution Valve. The valve is checked for proper functioning in the following way:

1. Disconnect fuel line at the valve-body connection, taking care not to damage threads.
2. Switch on the airplane battery.
3. Pump up fuel pressure.
4. Operate valve two times for approximately 5 sec. each time. Check rate of flow.
5. After operation of valve, observe and watch for continued leak; the maximum tolerance established and acceptable is contained in specifications.

Upon completion of this test, the fuel line is connected up again. Inspectors check reinstallation and if satisfactory accept it.

35.9. Fuel Strainers. The fuel strainer is checked as follows:

1. Put fuel valve control in "Off" position.
2. Remove strainer.

3. Inspect for cleanliness, condition of screen, supports on screen, and the sealing gasket.
4. Reinstall strainer after inspection.
5. Safety wire the installed strainer according to accepted aircraft standards.

35.10. Priming of Oil-pressure Instrument Lines. This is necessary to obtain correct readings on the instrument. Trapped air would act as a cushion and the reading would thus be not only incorrect but, no doubt, fluctuating. To expel any air the oil-pressure line is disconnected at the gage. Specified oil is forced into this line until it is full. The lines are then reconnected. Inspectors should watch this procedure and must make certain that all connections are tight after the check.

35.11. Oil Tanks. After putting into the tanks the proper amount and grade of oil, the lines and connections are inspected for leaks. Air is expelled from lines by removing the plug in the side of the engine oil-pump case. Upon completion, the plug is reinstalled and properly safetied.

35.12. Hydraulic System. To fill the hydraulic storage tank, the following procedure is followed:

1. The pressure is relieved in the pressure tank.
2. Certain hydraulic controls are put into specified positions.
3. The tank is then filled to the indicator mark.
4. The system is checked for leaks.

35.13. Heating System. To prepare this system, the following steps are taken:

1. The system is drained by opening all valves to release all water.
2. The drain valve is then closed and safetied.
3. The valve in the cockpit is turned to the "Off" position.
4. The tank is filled with the correct amount of distilled water.
5. System is checked for leaks.

35.14. Landing-gear Shock Absorbers. These are checked and inspected for

1. Leaks.
2. Adjustment.
3. Condition.

35.15. Fire-extinguisher System. This system is inspected for

1. Unused discharge indicator.
2. Any bottles (carbon dioxide) may be removed and weighed, if doubt exists as to charge contained.
3. Check and set release mechanism.
4. Check sealing wires on hand fire extinguishers.
5. Inspect distribution lines and connections.

35.16. Clearing of Airplane for Engine Run. The following must be checked for:

1. Records for previously described items cleared.
2. Brakes set and wheel blocks provided.
3. Covers, fairings, and doors secure.
4. Tire inflation correct.
5. Surface of ground under airplane and its immediate vicinity clean.
6. Battery cart on hand.
7. Fire-fighting equipment on hand and ready for instant use.

35.17. Safety Precautions. The following must be checked for:

1. Personnel clear of ship.
2. Doors and hatches secure.
3. All clear back of airplane.
4. Landing-gear safety pins in place.
5. Fire precautions taken (fuel cleaned off or allowed to evaporate).
6. Personnel present familiar with fire equipment.
7. Fire equipment inspected, full of carbon dioxide, and ready.
8. Ground clean of debris such as papers, rocks, and pieces of wood.

35.18. Propellers. Propellers are turned over by hand at least three full turns before the engine may be started.

35.19. Breather and Vent Lines. Breather and vent lines are checked for safety, and it is ascertained that their free ends are open.

35.20. Conclusion. To prepare correctly for and ensure a successful and safe first engine run, all personnel connected with it must apply itself to the task in a most cooperative, diligent, and attentive way.

CHAPTER XXXVI

THE ENGINE-RUN CHECK

Engines are started in accordance with authorized technical information.

36.1. Manifold Pressure. With the oil and cylinder heat at the proper temperature the engine can be turned up to a specified manifold pressure and a reading made of the instruments to see that everything is working normally. Each engine is rated at a certain horsepower for a given manifold pressure. This is checked at maximum throttle in full low pitch.

36.2. Oil Pressure. Each engine has an adjustable oil pump and must be set to give the proper pounds pressure recommended for the engine.

36.3. Fuel Pressure. The fuel pressure is checked to see that the proper pressure is available to operate the engine. This must be set very close on a pressure carburetor; for excessive pressure will damage the carburetor, and too low a pressure will starve the engine.

36.4. Vacuum Pressure. The vacuum pressure is checked for pressure to the vacuum-operated instruments and the automatic pilot. The vacuum pressure is adjustable. The automatic-pilot vacuum, the turn-and-bank indicator, and the horizon are set to specified inches of vacuum. The automatic-pilot oil pressure is set to specifications furnished by the manufacturer of this equipment.

36.5. Carburetor Heat. The carburetor is checked for temperature against the outside-air temperature to see that there is no hot air being taken through the scoop. It is also checked in the hot position to see that there is a normal temperature rise, for this is used to de-ice the inside of the carburetor.

36.6. Pressure Check at Idle R.P.M. The engines are now idled back to check the pressures at idle speed and the idle r.p.m.

36.7. Propeller-switch Setting. The engines are run at specified inches of boost while the magneto switches are checked out.

The engines are run up a little higher than the high-pitch propeller is set for and are then pulled back into high pitch. The engines will then slow down to the setting that is made for high pitch and will not turn up any faster, regardless of what position the throttles are in. Each customer has his own setting for this.

36.8. Carburetor-heat Control. With engines turning up at 1500 r.p.m. at least, turn the carburetor heat on to check for heat rise. Heat will vary, depending on the type of collector-ring and carburetor. This heat is used for de-icing the carburetor. It is very important that it is operative in the winter months.

36.9. Wing De-icer. Wing de-icers are operated from the pressure side of the vacuum pump.

In making this check, watch the pressure and the sequence of operation of the boots. The sequence most commonly used is that in which the center tube on the wing boots comes up first. This loosens the ice formed on the boots. Then the two outer tubes come up on the same boot. This throws the ice off. From here the sequence goes back to the tail surfaces, all three boots which are of the single-tube type being thus operated.

36.10. Landing Flap and Hydraulic Pump. These two checks are made at the same time. With the engine-pump selector turned on, put the flap valve in the proper position and watch the indicator. When flaps are fully extended, check the pressure gage to see that the pump is operating and building up pressure. If the airplane is equipped with more than one engine, make the same check on the other engines on which hydraulic pumps are installed.

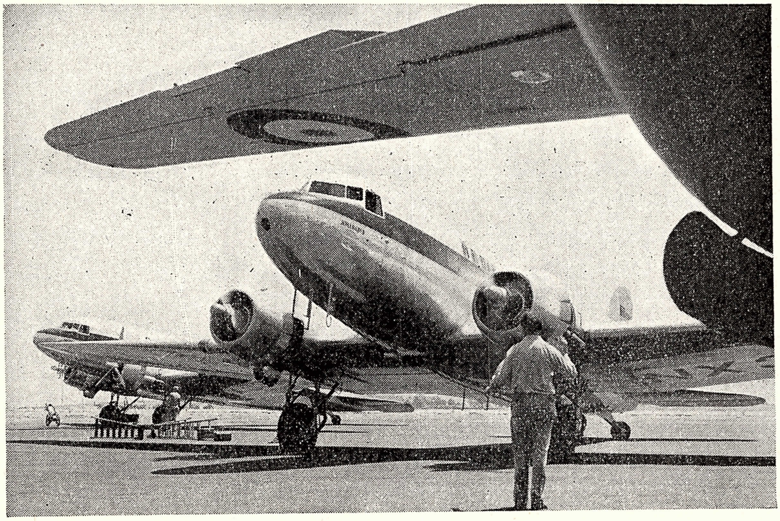
Time the flaps while they are coming up.

36.11. Synchronization of Propeller and Throttle Controls. This is one of the most difficult operations to get a proper setting on.

As an example, we shall use an engine that turns up 2400 r.p.m. at 45 in. of boost with a propeller setting of 88 deg. high-pitch and 16 deg. low-pitch setting.

With throttle set to give 45 in. boost and propeller governors full forward, the r.p.m. will go a little over 2400 and then settle back to and hold 2400. At a slight movement back on the propeller-control lever, toward the high-pitch side, governors should start operating. If too much lag is noticed here, reset the governor. When this first step is completed, check the propeller governors for synchronization with throttles. When the run is complete, propeller and throttle levers should be closely synchronized; engines should turn at 2400 r.p.m. without any tendency to turn faster, and levers should be synchronized throughout the range. Check the r.p.m. in full high pitch.

36.12. Tank Line to Engine Checked against Fuel-selector Valve. While making these checks on the engine accessories, make a tank-selector-valve check. On the first engine run, make a 5-min. run on each tank, noting the gas-quantity gage for the tank being run on.



A motor run at high r.p.m. on a Douglas commercial airliner. (*Courtesy of Douglas Aircraft.*)

36.13. Idle Cutoff. On engines that have pressure carburetors installed, there is a provision made for shutting the engine off by the use of the idle-cutoff control; if this should fail to operate, it would have to be adjusted before the engine run could be accepted.

36.14. Propeller Feather. Turn the engine up a little above high-pitch r.p.m., and pull propeller in full high pitch. When engines pull down to high-pitch r.p.m., then engage the propeller-feather switch and the engines will pull down to their full feather position; hold the switch down to unfeather.

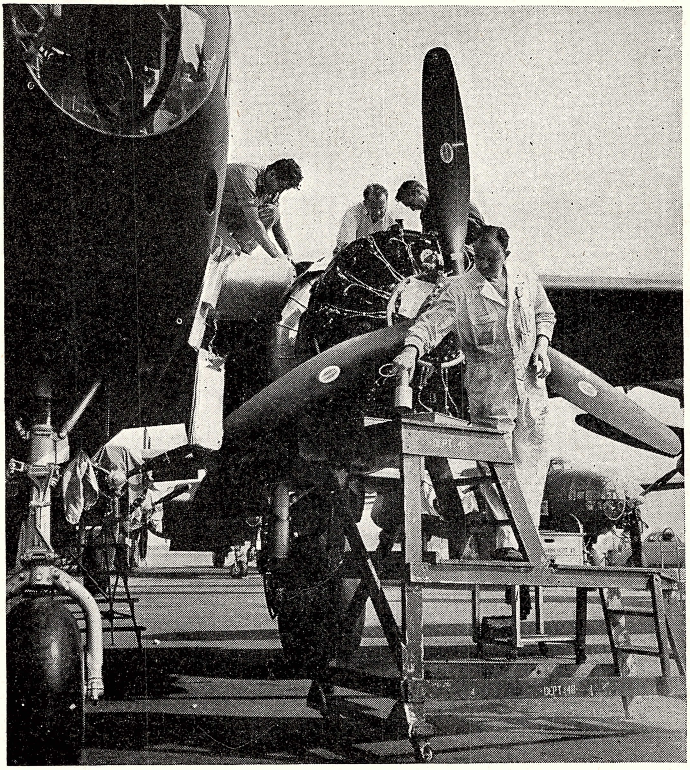
36.15. Automatic-pilot Operation. If the airplane is equipped with an automatic pilot, its operation and function are checked according to approved information furnished by the manufacturer and by factory authority.

36.16. Conclusion. Inspectors accepting an engine run are to be familiar with all technical requirements. When in doubt on any point, they are to consult their immediate superior without fail. It is important that procedures established by factory authority be strictly adhered to.

CHAPTER XXXVII

INSPECTION OF POWER PLANT AFTER FIRST ENGINE RUN

37.1. Introduction. Upon completion of the first engine run, inspection is carried out as before the first engine run. However, certain operations, such as priming the instrument lines, are omitted. Attention is given to conditions resulting from the running of the engine, such as torque and vibration effects, if any.



Inspection after motor run is completed. (*Courtesy of Douglas Aircraft.*)

The following are checked and inspected after their initial runs:

1. Various systems.
2. Antidrag-ring installation.
3. Cowl flaps; fixed flaps.
4. Propeller.
5. Intake and exhaust systems.
6. Carburetor.
7. Engine mount.
8. Engine controls.
9. Accessories.
10. Engine as a whole.
11. Fuel and oil.

37.2. Various Systems. The fuel, oil, hydraulic, and heating systems in the power-plant section are inspected for

1. Leaks.
2. Alignment at connections.
3. Evidence of vibrational contacts.
4. Surface condition of tubing.
5. Condition and security of clamps, supports, and ties.
6. Security of attachment of auxiliary units such as propeller feathering pump and relief valves.

37.3. Antidrag-ring Installation. This is inspected for

1. Alignment, tension, and safety of the trunnion bolts
2. Fit and condition of fore and aft cowl stops.
3. Clearances and fit of cowling segments.
4. Condition of skin and riveting.
5. Condition, safety, and alignment of Dzus fasteners.
6. Condition, fit, and surface contacts of rubber mounts.

37.4. Cowl Flaps; Fixed Flaps. These are inspected for

1. Clearances between flaps and engine diaphragm, when flaps are closed.
2. Angular travel and contour alignment when flaps are open.
3. Condition of surface exposed to overlapping of flaps.
4. Condition and safety of hydraulic actuating unit.
5. Clearances of hydraulic-unit installation and diaphragm.
6. Position of actuating levers in open or closed position with reference to clearances at cutouts, alignment at bearings, and safety of the connecting links.

37.5. Propellers. These are inspected for

1. Oil leaks.
2. Safety (condition and installation).
3. Index markings of degrees.
4. Safety of propeller governor.
5. Condition of governor controls.
6. Condition of safety provision on governor adjustment.
7. Condition of surfaces on propeller blades.
8. Condition of antiglare paint.
9. Condition of propeller de-icer provisions.
10. Operation of propeller governor.

37.6. Intake and Exhaust Systems. These are inspected for

1. Condition, safety, and clearances.
2. Condition and safety of boiler installation.
3. Leaks and cracks (entire system).

37.7. Carburetor. This is inspected for

1. General condition.
2. Safety.
3. Alignment.
4. Safety, operation, clearances, and travel of controls.
5. Condition and safety of carburetor-scoop installation.
6. Condition and safety of carburetor air-temperature bulb installation.
7. Condition and safety of carburetor vent-line installation.
8. Condition and cleanliness of carburetor intake.

37.8. Engine Mount. This is inspected for

1. Condition of welds.
2. Condition of paint.
3. Condition and safety of attaching bolts on firewall and motor hangars.

37.9. Engine Controls. These are inspected for

1. Condition, safety, clearances, and tension of cables.
2. Correct travel of controls through entire operating range.
3. Synchronization with position of control handles in pilot's cockpit.

37.10. Power-plant Accessories. These are inspected for

1. Condition and safety of installation and connections on generator, starter, oil pump, fuel pump, vacuum pump, and propeller feathering pump.
2. Leaks at base connections of above units.

3. Condition, safety, supports, and clamps of systems connecting to above units.

37.11. Engine as a Whole. The engine as a whole is inspected for

1. Leaking of oil at case connections.
2. Safety of engine-pipe plugs.
3. Safety of dilution-valve installation.
4. Safety of engine crankcase bolts.
5. Condition of cylinder fins.
6. Condition and safety of valve-mechanism housings.
7. Condition and safety of attachments and firewall.

37.12. Conclusion. Inspection after the first engine run is to be carried out carefully and diligently. Questionable conditions must be brought to the attention of one's immediate superior.

CHAPTER XXXVIII

SAFETY INSPECTION FOR FLIGHT

38.1. Introduction. After the engines have been run and found satisfactory, the entire airplane is given an inspection.

The purpose of this inspection is to ensure the safety of the airplane, its installations, and its various major components. Systematic and diligent attention to this task is essential. The results will be most gratifying in that an enviable record of safe airplanes will be obtained and kept unbroken.

Inspection of power plants before and after the run has been discussed previously and therefore will not be treated here.

38.2. Procedure. The procedure may be classified according to units, as follows:

1. Fuselage.
2. Inner wings.
3. Outer wings.
4. Doors, enclosures, etc.
5. Furnishings.
6. Electrical installations.
7. Empennage.
8. Flight controls.
9. Engine controls (cockpit to power plant).
10. Radio installations.
11. Ballast.
12. Records.

38.3. Fuselage. The fuselage consists of the following:

1. Nose section.
2. Pilot's cockpit.
3. Crew quarters (rear cockpit, or passenger compartments).
4. Tail section.

38.4. Nose Section. The nose section is inspected for

1. Cleanliness.
2. Safety, condition, and cleanliness of window installations.

3. Safety, completeness, and operation of all types of installation, *viz.*, seats, valve manifolds, instruments, furnishings, covers or doors, etc.
4. Condition of fluid-carrying systems (no leaks).

38.5. Pilot's Cockpit. The pilot's cockpit is inspected for

1. Operation and safety of installation of seat or seats.
2. Cleanliness, operation, and safety of installation of windows.
3. Completeness, installation, safety, bonding provisions, cleanliness, correct color identification (individual-instrument operating ranges), tightness of tubing, conduit connections, clearances, etc., of the instrument panel.
4. Safety and cleanliness of flooring installations.
5. Safety of all operating handles.
6. Completeness of all identification provisions, such as name plates, instruction plates, and stencils.
7. Condition and safety of seat-belt installations.
8. Condition, fit, operation, and safety of escape doors, or hatches.
9. Correct installation, satisfactory operation, and safety of emergency provisions.
10. Safe and proper installation of furnishings and equipment, such as cushions, report cases, drinking-water containers, and fire extinguishers.
11. Absence of leaks in fluid-carrying systems.

38.6. Crew Quarters (Rear Cockpit, or Passenger Compartments). These are inspected for the following:

1. Cleanliness, no loose articles.
2. Stenciling complete.
3. Seats or other seating provisions safe and operating.
4. Enclosures and emergency-exit provisions, if any, operating, safe, and fitting correctly.
5. Windows clean.
6. Doors or escape hatches operating, safe, and complete.
7. Safety belts provided.
8. First-aid equipment, if called for.
9. Paper cups provided.
10. Lavatory or relief tubes in condition for flight.
11. Drinking water or provisions, if called for.
12. Removable floors installed securely.

13. Fire-extinguisher provision installed and ready for use.
14. Water drains, if any, open.
15. Provisions for entrance steps safe and operating.
16. Furnishings such as cushions or report holders installed and safe for use.
17. Appearance of section in general satisfactory.
18. Absence of leaks in fluid-carrying systems.

38.7. Tail Section. This is inspected for the following:

1. Cleanliness and freedom from loose articles.
2. Floors clean and securely installed.
3. Windows, if any, clean.
4. Furnishings secure and safe, such as provisions for storing or carrying tools or surface locks.
5. Safety of attached surface assemblies and fixed vertical and horizontal stabilizers.

38.8. Inner Wings. These are inspected for the following:

1. Safety of attachments.
2. Safety of stress plates.
3. Condition of skin surface.
4. Fit, condition, and safety of inspection covers.
5. Fit, condition, and safety of fillets.
6. Stencil complete.
7. Safety of provisions for control surface attachments.
8. Safety of wing-landing-flap installations.
9. Safety, clearances, etc., of tubing and conduit installations.
10. Absence of leaks in any liquid-carrying system.
11. Condition of de-icer-equipment installation, if any.
12. Condition and safety of jack pads.
13. Fit and condition of tank-filler neck seals.
14. Safety of landing gear.

38.9. Outer Wings. These are inspected for the following:

1. Safety of attachments.
2. Sealing provisions, if called for.
3. Condition of surfaces.
4. Condition, safety, clearances, and throws of flight-control surfaces.
5. Safety of electrical installations.
6. Safety of wing lights.
7. Safety and condition of any de-icer provisions.
8. Safety of inspection cover plates.

9. Stenciling complete.
10. Instruction and name plates correct and installed.
11. Pitot tube open, secure, and in alignment.

38.10. Doors, Enclosures, Etc. These are inspected for the following:

1. Safety of operation and installation.
2. Fit and watertightness.
3. Safety latches installed and operating.
4. Emergency-release provisions installed.
5. Stencil correct and complete.
6. Windows clean.

38.11. Furnishings. These are inspected for the following:

1. Safety of seat installations.
2. Operation of seats.
3. Seat belts provided and installed safely.
4. Fire-extinguisher units installed and ready for use.
5. Flight and record sheets in place.
6. Drinking water, cups, etc., in place.
7. Color identification on all operating handles.
8. Stencils correct and none missing.

38.12. Electrical Installations. These are inspected for the following:

1. Fuses installed.
2. Fully charged batteries in place and secured.
3. Battery vents open.
4. Identification plates (none missing).
5. All circuit operating correctly.
6. Stencils correct; none missing.
7. Electrical connections tight.
8. Safety of electric-unit installations.
9. Air-speed Pitot-tube heating unit operating.

38.13. Empennage. This is checked for

1. Safety of attachments.
2. Condition of surfaces.
3. Safety and condition of de-icer provisions, if any.
4. Clearances, safety, and direction of throws of flight-control surfaces.
5. Alignment of trailing edges in neutral.
6. Compliance with paint-finish specifications.
7. Safety and condition of electrical equipment.

8. Pitot tube open, secure, and in alignment, if installed on vertical stabilizer.

38.14. Flight Controls. These are inspected for

1. Safety.
2. Correct direction and amount of throws.
3. Safe clearances.
4. Safety and condition of flight-control surfaces.
5. Physical effort required to operate controls.
6. Compliance with lubrication requirements.
7. Absence of all loose articles that might foul the system.
8. Correct banding.
9. Correct cable tension.
10. Alignment of trailing edges.
11. Operation of controls (hitting stops as required).

38.15. Engine Controls (Cockpit to Power Plant). These are checked for

1. Correct operating range.
2. Correct synchronization of controls.
3. Safety and clearances of controls.
4. Correct banding.
5. Correct tension on cables.
6. Correct tension on control quadrants.
7. Correct identification of control handles.
8. Safety.

38.16. Radio Installations. These are checked for the following points:

1. Installations safe.
2. All dials set.
3. Sets operating correctly.
4. Antenna installations safe.
5. Compass swung.
6. Compass-correction cards in place.
7. Remote controls operating correctly.

38.17. Ballast. This is inspected for

1. Type.
2. Location.
3. Weight.
4. Security of installation.
5. Safety of equipment installation.

38.18. Records. These are inspected for the following points:

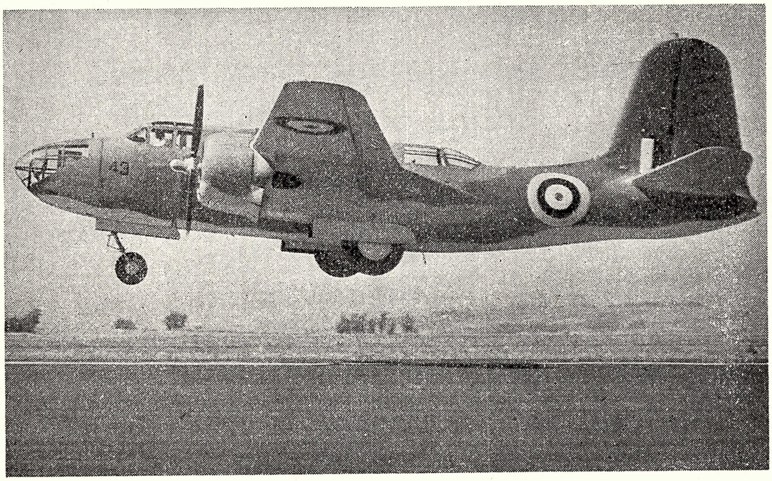
1. All corrections made by field personnel entered.
2. All entries checked and stamped out.
3. Flight and pilot's records correctly and properly filled in.
4. All former inspection records complete and in order.

38.19. Conclusion. The importance of the safety inspection cannot be overemphasized. Inspectors in this branch of the work must be thorough, attentive, and diligent at all times, for the safety of pilot, crew members, and airplane depends wholly on the success with which the task has been done. Inspectors are strongly advised to consider unsafe any condition open to question or doubt and to consult their superior without delay. Cooperation with production personnel is essential for successful safety inspection.

CHAPTER XXXIX

PREFLIGHT INSPECTION

39.1. Introduction. As the title of this chapter implies, this inspection is made just prior to the first flight of the airplane. The procedure may vary in different cases owing to the differences in elapsed time between safety inspection for flight and this preflight inspection. Should the airplane be flown immediately after the safety check, preflight inspection will be confined to the engine warm-up. Should, however, a considerable amount of time have elapsed between the two inspections, preflight inspection will consist of the following procedures.



Take-off of Douglas-built English attack bomber. Landing gear partly retracted. (*Courtesy of Douglas Aircraft.*)

39.2. Engines. These are inspected as follows:

1. Check condition of propellers, safety, blade surfaces, etc.
2. Check for oil leaks.
3. Inspect for loose or missing safety nuts or cotter pins.
4. Inspect propeller-control unit.
5. Note condition of spark-plug connections.

6. Inspect installation of antidrag ring, fit, safety, and fasteners.
7. Check for condition of safety-wire installations.
8. Inspect closely for loose parts or tools.

39.3. Accessory Section. This is inspected as follows:

1. Remove side sheets.
2. Check for oil leaks.
3. Be sure there are no incomplete accessory installations.
4. Inspect closely for safety of all accessory adjustment provisions, such as oil-pressure adjustment, fuel-pressure regulator, idle-mixture lock screw, and plugs in carburetor.
5. Check for loose hose clamps, safety missing or incorrectly installed, and condition of bonding provisions.
6. Inspect condition of turnbuckles, safety, clearances, and tension of cables.
7. Inspect closely all antidrag-ring fasteners for security, seating in surface metal, penetration, and locking of Dzus fastener slot and spring.
8. Note general condition of power-plant section by visual observation.

39.4. Nacelles and Landing Gear. These are inspected as follows:

1. Check for oil leaks aft of firewall.
2. Inspect for loose parts, dirt, etc.
3. Inspect safety of installation (no missing cotter pins or loose lock nuts; electrical connections secure; pulleys and their supports; fairleads).
4. Check and inspect safety of landing-gear truss installation, hydraulic actuating unit, hose connection, locking mechanism, and lubrication.
5. Inspect, if provided, outlets of fire-extinguisher tubing (must be open).
6. Visually note condition of all bonding provisions and door hinges and how secured.
7. Visually note whether any screws or bolts are omitted in any stress plates, doublers, etc.
8. Visually note clearances near any installations.
9. Inspect shock absorbers for proper adjustment.
10. Inspect tire pressure by referring to tire marks.
11. Note condition of tire surfaces.

12. Visually check safety of wheel plate and alignment of tire-slippage indicating marks.

NOTE: The same procedures are applicable to the nose-wheel or tail-wheel section.

39.5. Wings, Outer and Inner, and Empennage. These are inspected as follows:

1. Check amount of fuel and oil in tanks; make proper entries on records.
2. Inspect safety of tank-cap installations after closing up of tanks.
3. Inspect for any obstructions all vent-line outlets.
4. Inspect for safety all inspection doors and cover plates, and note condition of fairings and their attachments.
5. Inspect condition of fabric on flight-control surfaces.
6. Check safety of attachment on ailerons, elevators, and rudder.
7. Note amount of clearances, alignment of trailing edges, etc.
8. Inspect condition, safety, etc., of all tab installations.

39.6. Fuselage Outside. This is inspected as follows:

1. Check for cleanliness of windows.
2. Inspect safety of all cover plates, doors, and hatches.
3. Note whether or not cover is removed on air-speed Pitot tube.
4. Visually observe safety of antenna installation.

39.7. Fuselage Inside. This is inspected as follows:

1. Inspect provisions for safety (safety belts, fire extinguishers in place, compass card in place, entire interior clean and free of loose equipment, surface-control locks stored in ship, cushions provided, etc.).
2. Check hydraulic-fluid supply.

39.8. Flight Controls. While in cockpit, operate and note movement and direction of flight-control surfaces.

39.9. Preparations for Engine Warm-up. These are as follows:

1. Fuel strainers drained and inspected for safety.
2. Heating system drained and refilled with distilled water.
3. Fire-extinguisher equipment ready.
4. Propeller pulled through at least three complete revolutions.
5. Pitot-tube cover removed (if not done previously).
6. Battery cart plugged in.

39.10. Starting and Running of Engines. The procedure is as follows:

1. Start engines according to technical instructions given in the operation handbook.
2. Check and verify instrument readings; record these.
3. Operate all flight and engine controls, and note ease or freedom of movements and direction as called for by design requirements.
4. Precautions must be taken so that no injury may be suffered by ground crew.
5. Doors and hatches must not be opened where danger exists due to propeller blast.
6. Pay close attention to oil temperature, for correctly-timed functioning of the automatic oil-cooler valves and shutters is most important.
7. Make certain engine cowl flaps are open during engine run.

39.11. Final Engine Run-up. The following procedure is suggested:

1. Idle engine, and take instrument readings as required by the specifications.
2. Check propellers for feathering operation in accordance with authorized technical procedure.
3. Check manifold pressure during high-speed run.
4. Watch closely the cylinder temperatures; overheating must be prevented.
5. Only for a very brief time should the throttle be opened fully, and then this must be done smoothly.
6. A full throttle run is made *only* before first run of day or when there is reason to believe this check is needed to establish safety for flight.

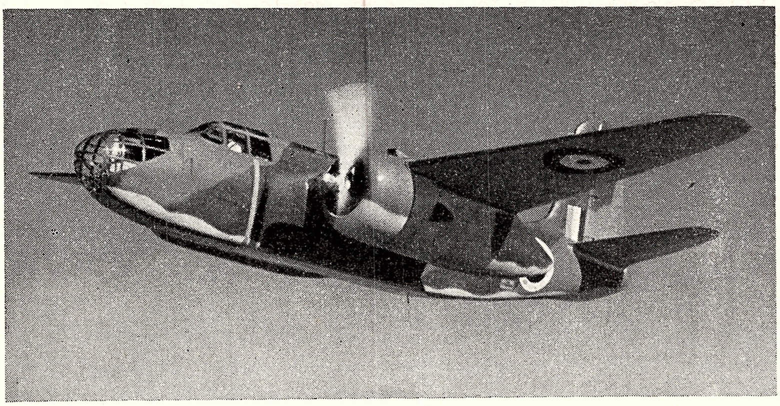
39.12. Miscellaneous. Other points to be noted are as follows:

1. Radio equipment must function correctly.
2. Radio operation must be checked during engine run.
3. Oxygen equipment, if called for, must be inspected and found to comply with all technical requirements.
4. If oxygen turnon valves are inaccessible while airplane is in flight, such valves *must* be turned on before flight is o.k.'d.

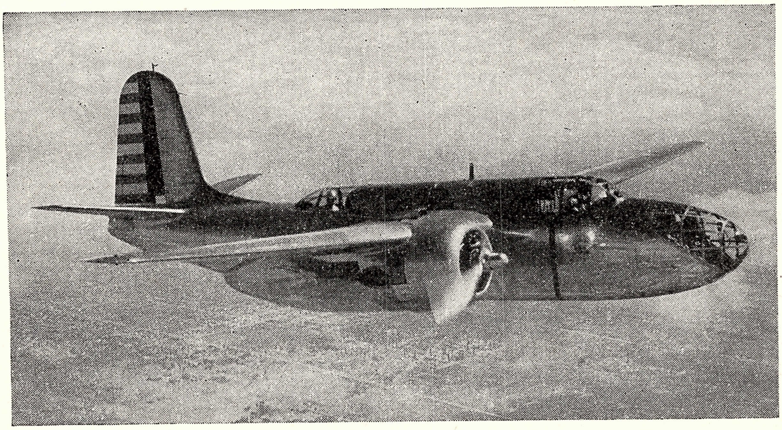
39.13. Final Checking before Take-off. This includes the following:

1. Records complete and signed out by the personnel and pilot involved.

2. All doors, covers, etc., closed and securely latched. If provided with lock and not expected to be opened, the door or cover involved should be locked with the key and the key given to the pilot.



Douglas-built English attack bomber in flight, note camouflage on ship. (*Courtesy of Douglas Aircraft.*)



Douglas-built attack bomber in flight. (*Courtesy of Douglas Aircraft.*)

3. Any outside provisions for access such as fuselage and extension step to be retracted.

4. At pilot's signal, the landing-gear locking provisions removed and, if possible, stored in their provided location on inside of the airplane.

39.14. Conclusion. The responsibility of inspection signing out an airplane for its first flight is great. All inspection procedures, checks, and operations preparatory to flight must be accomplished with the earnest desire to obtain the safest airplane possible. Cooperation with the ground personnel will make this task easier. A pilot's respect will be earned by safe and dependable airplanes being released for flight.

CHAPTER XL

DELIVERY INSPECTION

40.1. Procedure of Delivery Inspection. The purpose of inspection of the airplane prior to delivery is as follows:

1. To correct any condition affecting the proper and safe functioning of any part or installations.
2. To make certain that any incomplete items are definitely completed.
3. To service the airplane for delivery flight.
4. To rectify any unsatisfactory items on pilot's report.

The following inspection precedure is suggested:

40.2. Propellers. These are inspected as follows:

1. Check for oil leaks.
2. Check for damaged blades.
3. Check for safety of propeller installation.

40.3. Engine and Accessory Section. These are inspected for the following:

1. General condition and safety of engine.
2. Condition of engine mount.
3. Excessive dirt or oil.
4. Oil leaks at back of engine accessory case.
5. Leaks in fuel system.
6. Tension of control cables.
7. Missing cotter pins or safety wire.
8. Loose lock nuts.
9. Loose hose or line clamps.
10. Lines and conduits wearing because of lack of clearance or improper installation.

40.4. Cowling. This is checked for

1. Fit.
2. Wear.
3. General condition.
4. Safety.

40.5. Oil System. This is checked for

1. Leaks.
2. Damaged lines.
3. Hose connections.
4. Safety of clamps and supports.
5. Clearances (check for evidence of contact with adjacent installations).
6. Bonding provision in good condition.
7. Magnetic plug (remove; inspect particles clinging to it; reinstall).
8. General condition and safety.

40.6. Fuel System. This is checked for

1. Fuel screens (remove, clean, reinstall, and safety).
2. Leaks in tubing; general condition of tubing.
3. Hose connections and fitting alignments.
4. Condition of vents.
5. Safety of tank filler caps.
6. General safety and condition of system.

40.7. Engine Controls. These are checked for

1. Tension, condition, and safety.
2. Operation for check on control travels.
3. Clearances at cutouts, etc.

40.8. Flight Controls. These are inspected as follows:

1. Open all inspection doors (those not permanently closed).
2. Check condition, tension, and safety of cables.
3. Check clearances through entire range of movement.
4. Check condition and safety of flight control surfaces and their attachments.
5. Check correct direction of throws.
6. Check controls hitting provided stops.
7. Check general condition and safety of installations.

40.9. Wing Landing Flaps. These are inspected for the following:

1. Condition.
2. Safety of installation.
3. Clearances (check for any evidence of rubbing).
4. Leaks on hydraulic actuating cylinders.
5. Safety on cylinder-travel adjustment.
6. Bonding provisions in good condition.

40.10. Main-wing Bolts. These are inspected for their safety and the general condition of the installation.

40.11. Landing Gear. These are inspected for the following:

1. Safety.
2. Latch mechanism.
3. Warning provisions.
4. Clearances.
5. Lubrication.
6. Shock-absorber adjustment.
7. Condition of tires.
8. Inflation of tires.
9. Slip marks matching on tire and wheel rim.
10. Security of wheel covers.
11. Fit of landing-gear safety pins or collar.
12. Safety and adjustment of snubber unit.
13. Condition, safety, and bonding of landing-gear doors or covers.

40.12. Heating System. This is inspected as follows:

1. Check for leaks.
2. Drain and refill (with distilled water).
3. Check operation of provided controls.
4. Check safety of system and its installation.
5. Check general condition and appearance.

40.13. Hydraulic System. This is checked for

1. Leaks.
2. Condition of tubing and connections.
3. Amount of air in pressure tank.
4. Fluid level in supply (storage) tank.
5. Condition and safety of actuating units.
6. Bonding provisions.
7. Correct stenciling.
8. Condition and safety of entire system.

40.14. Doors and Hatches. This is checked for the following points:

1. Safety of attachments.
2. Alignment of locking devices.
3. Condition of emergency-release mechanism.
4. Fit and seal of doors and hatches.
5. Stenciling correct; none missing.

6. Amount of physical effort required to open or close doors.
7. Drain provisions open.

40.15. Instruments. These are checked for

1. Correct indications in "Off" and "On" positions.
2. Appearance.
3. Markings.

The U.S. Army takes delivery of Ryan primary training planes. (*Courtesy of Ryan Aeronautical Co.*)

4. Limiting operations.
5. Connections.
6. Attachment to panel.
7. Safety of installations.

40.16. Name Plate. This is checked for the following points:

1. Acceptance date.
2. Stamp of representative accepting airplane.

3. Security of attachment.
4. Neat, clean appearance.

40.17. Accessory Parts. These are checked for the following points:

1. Compliance with shipping list.
2. Location of parts for weight distribution.
3. Security of attachments.
4. Signature on records.

40.18. Conclusion. Delivery inspection of an airplane is a responsible task. The safety of the pilot, crew members, and the airplane itself depends on the reliability of this inspection. The condition in which an airplane arrives at its destination and the report of the personnel flying the plane are the measure of the quality of the inspection the airplane received prior to its release for delivery. A reputation for reputable inspection represents a great achievement. Such a reputation must be guarded jealously because of its value to the inspectors themselves, to the aircraft manufacturer, and to the customer.

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Co-Owners —

Myra Phillips - 14a

Suzanne Allemand - 14a

To whom it may concern -

This book was bought by two lonely young ladies, students of the Naval Aircraft School. If found please lose again or burn or some-thing but Do not return to the above.

I thank you

June 1943 20th Century A.D.

AIRCRAFT INSPECTION